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The Institute of Vitreous Enamellers

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and

The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

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The International Association for Testing Materials

Those foundrymen who attended the second Congress of the International Association for Testing Materials, held in London last week, were rewarded with a series of most interesting meetings, interspersed with a full round of social entertainment and works visits. Their numbers were, however, small, which is all the more surprising in view of the paramount importance of the subjects discussed. For example, what foundryman is not concerned with the very important questions of "properties of materials at high temperatures," "the relationship between laboratory testing and life in service," or with "wear and machinability," whilst many associated with the industry must be interested in such cognate subjects as "progress in metallography" and "the bearing of recent advances in physics and chemistry on our knowledge of materials." Further, a special session was devoted to light alloys, and made extensive reference to castings.

The Congress was truly international, and of the members—totalling nearly 1,000—a large proportion were from overseas. Amongst these were many well known to the foundry industry and especially to those who regularly attend international conferences. Their presence tended, if anything, to emphasise the absence of British foundrymen.

No doubt a substantial factor accounting for the absence of the latter is the present pressure and urgency of business. Coupled with this is the plethora of conferences making demands on their time in the near future, but even these factors do not account fully for their absence. Perhaps there is a deeper and more subtle reason. Is it that foundrymen are still, in spite of their excellent organisations, lacking in technical consciousness and are inclined to adopt an isolationist attitude when such subjects as testing are discussed, are they inclined to leave it to "someone else"? On the other hand, a study of the Congress programme shows that among the two hundred odd Papers presented only two or three make direct reference to cast iron, although, of course, many—especially those dealing with various aspects of testing—are of indirect interest.

This last point seems to show that since the conference was organised mainly by engineers, the older attitude towards cast iron as an inferior kind of the metal tends to persist in spite of the wealth of information now available to all concerning the excellent properties now available in modern high duty cast irons.

If any moral can be drawn from these few observations on the Congress it would seem that the I.A.T.M. should be an admirable rendezvous where engineers and metallurgists, including foundrymen, could meet. That they did not do so at the London Congress is perhaps not so much the fault of the foundrymen as of the programme of the Congress, and the hope can be expressed that when the next meeting is held in Berlin in some 3 or 5 years time, more attention may be given to the testing and properties of cast iron. No apology is needed for this suggestion, for the modern high duty cast irons are now being included in such abstruse researches as those on creep and fatigue—and, after all, cast iron is still one of the prineipal materials of engineering construction, and its closer study has already borne fruit. Some onus is, of course, also on the foundrymen, and for the good of the industry as a whole let there be earlier and greater co-operation in the future.

A Metallurgical Qualification—II

In completing our consideration of the subject raised in our last issue, we wish to repeat that the question of a foundry qualification is not under discussion. That may be dealt with later. At present we are concerned with a general metallurgical qualification such as would appeal to many engaged in the laboratory or control side of founding as well as in the iron, steel and non-ferrous industries, in welding, enamelling, and so on. The first point is that no distinction should be made between ferrous and non-ferrous metallurgy. The distinction has never been a real one and daily becomes less so. The second point is that although a thorough knowledge of first principles must be postulated, the field is so wide that on the practical side students could not be expected to show detailed familiarity with more than one branch, and even in that one branch there may be differences due to variations in practice throughout the country and the localisation of certain types of manufacture. We think that something on national certificate lines would meet the requirements. The principles can be, and indeed are, taught at various technical institutions throughout the country. So far as these principles are illustrated in practice in the trades of each district, reflected in the experience of students in these districts, the certificate course would take these into account, because the teaching in any area will reflect the

(*Concluded on page* 344.)

Annual Meeting of the West Riding of Yorkshire Branch

The annual meeting of the West Riding of Yorkshire Branch of the Institute of British Foundrymen was held at the Bradford Technical College on April 24, the President (Mr. Joseph Hepworth, J.P., M.P.) presiding.

The Branch-Secretary (Mr. S. W. Wise) gave a *résumé* of the work of the Branch during the past year, and said it was very gratifying to reflect that in all the reports given for the past ten years some hope had to be expressed that trade would improve, but it could be stated on this occasion that conditions were very much better and there was reason to believe that a period of relative prosperity was before them. The improvement in industrial conditions had not been without effect on the Branch, in spite of the losses that had been sustained by resignations, transfers to other Branches, and the deaths of three members, Mr. W. H. Hartley, Mr. H. Derrington and Mr. C. W. Kent—the last-named soon after his election as a member of the Council. The membership of the Branch had increased by eight, and the amount paid in subscriptions was only about five pounds below the potential resources of the Branch. All meetings arranged by the Council had been held, including two very interesting works visits. As was hinted in the last report, the past session was to be one of outstanding importance on account of the election of Mr. Hepworth to the office of Junior Vice-President of the Institute. There was every reason to believe that the annual conference of the Institute would be held in the West Riding in June next year, when the Branch would be signally honoured because it would be the first occasion that a member of the Branch had been chosen as President of the Institute. The secretary said he had no doubt that the conference in 1938 would be worthy of the Branch.

Pig-Iron Situation

Mr. H. Forrest, who was elected Branch-President for the ensuing year, was unable to be present, but had sent a letter in which he referred to the present position of foundry raw materials, particularly pig-iron. He thought they would all be glad to see the general revival in trade, and although some of it was due to rearmament there was no doubt that a large portion of it was due to a more optimistic outlook of the general public. The present position for users of pig-iron was most alarming, and prices quoted to-day showed increases in some cases amounting to 50 per cent. on their value twelve months ago. This, together with an acute shortage and considerable decline in quality, was causing most foundrymen to view the immediate future with apprehension. One could not help thinking that the present position had been artificially created, and that shortage of supplies had been deliberately caused to force prices upwards. In some cases trouble in Spain might have curtailed supplies of iron ore, but that could not be the reason for the failure of the majority of blast-furnace plants to cope with the demand for pig-iron. Most manufacturers took advantage of the recent slump to overhaul their methods and plant, knowing full well that a revival in trade would follow. They had now reached that revival and it would appear that the owners of blast-furnace plants had pursued a short-sighted policy in the past. Many makers of foundry iron products were now producing a basic pig-iron for steel works, to the total disregard of their old foundry customers. He was well aware that the Institute of British Foundrymen did not, and should not, concern itself with trade policy, but he felt there were many members who would wish that the blast-furnace owners would give some attention to their demands.

The following officers were elected:—*Senior Vice-President*, Mr. S. Carter; *Junior Vice-President*, Mr. H. A. McColl; *hon. secretary and treasurer*, Mr. S. W. Wise. There were four retiring members of the Branch Council and Mr. F. Squires, Mr. N. W. Riley, Mr. G. Copeman and Mr. L. Turner were elected to fill the vacancies. *Hon. auditors*, Mr. H. A. McColl and Mr. N. W. Riley; *hon. librarians and registrars*, Mr. H. Bradbury and Mr. F. Squires; *delegates to General Council*, Mr. W. G. Thornton and Mr. A. S. Worcester; *representatives on the Technical Committee*, Mr. F. K. Neath and Mr. S. Carter.

It was agreed that a sub-committee be formed to commence preparations for the 1938 conference to be held in the West Riding of Yorkshire, and the following were appointed:—Mr. Neath, Mr. Thornton, Mr. Worcester, Mr. Riley, Mr. A. W. Walker, Mr. Hepworth, Mr. W. Fearnside and Mr. McColl.

A Metallurgical Qualification—II

(*Concluded from page* 343.)

industrial practice of the area. It is also well known that in such courses a considerable proportion of the questions are set by the teaching authorities, subject to the approval of, and possible alteration by, independent and impartial assessors. We therefore visualise something doing for metallurgy what present national certificates do for mechanical and electrical engineering, chemistry, and so on, and on somewhat similar lines fitting into the same general framework, and suggest that the authorities concerned might take the matter further.

Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Soda Ash and Furnace Linings

To the Editor of The Foundry Trade Journal.

Sir,—We notice in your report of Mr. Spiers' Paper on "Cupola Practice" (The Foundry Trade Journal, April 22, p. 327) that he pays tribute to the value of soda ash (sodium carbonate) for producing clean iron and clean ladles, but expresses the opinion that it is very severe on the furnace lining and "as hand-charging is practised, the gas produced is objectionable to the man charging." We assume that Mr. Spiers is referring to the use of fused sodium carbonate blocks, the only form of this flux suitable for charging to the cupola.

We should like to point out that a very large number of firms are using fused sodium carbonate regularly in this way, and have been doing so for a number of years without noticing any abnormal attack on the cupola lining. Indeed, one of your correspondents some time ago pointed out that fettling costs are considerably reduced, and the life of the lining is lengthened, by its use (The Foundry Trade Journal, July 5, 1934, p. 2). The only possibility which occurs to us is that the joints in the brickwork of Mr. Spiers' cupola were already in poor conditions before he began using sodium carbonate. Under such circumstances trouble would be expected.

With regard to "objectionable gas," we are frankly puzzled by Mr. Spiers' remark. Sodium carbonate is a well-known chemical, supplied in a very pure condition. It dissociates when heated, evolving carbon dioxide, which surely cannot be regarded as objectionable when there is so much more of it produced in the same place by the combustion of coke.

We hope that this letter will clear up any misconception which might be caused by Mr. Spiers' remarks in an otherwise most interesting and informative Paper.—Yours, etc.,

R. L. Evans
(for I.C.I. (Alkali), Limited).

Research Department, Winnington.
April 24, 1937.

Random Shots

The Congress of the International Association for Testing Materials finished its week on a happy note, with visits to Cambridge, Oxford, and Windsor, on, fortunately, a perfect spring day. Perhaps the visitors from abroad, sniffing their first breath of fresh air since they crossed the Channel, and noting with a Continental eye of envy the ancient lawns of those cities, would get some inkling of the yearning of the poet who wrote: "Oh to be in England now that April's here." Those visits must have been especially welcome after a week of late nights, culminating in the dance and cabaret at Grosvenor House on Friday night. The physical strain of dancing the many Viennese valzes and Paul Jones was almost capped by the mental strain of finding out the mother tongue of one's partner. Indeed, almost throughout the congress one had to preface one's remarks with "Sprecken-sie, parlez-vous, English?"

* * *

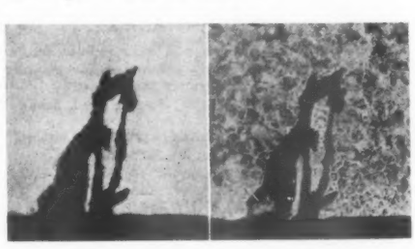
London, having no sooner bid farewell to the Congressists from abroad, is ready to greet a very different set of visitors on Saturday, for there will be a gradely lot of Northerners "up for t'cup final." It is to be hoped that they will celebrate *after* the match and not in the train, as it would be so easy to mistake the Coronation stands for the Stadium—and North Country folk like to see something for their brass.

* * *

It is difficult to find in England any small town or even large village which does not possess a foundry, be it ever so humble. There is an island far far away, however, that cannot boast a solitary example. Some foundry-owner who has been suffering from insomnia since Mr. Chamberlain's Budget was announced, might be pleased to hear that this island is far beyond the reach of the British Tax Authorities. New Guinea would be an attractive site to move to, even better than Welwyn Garden City, if one can judge by an announcement in one of its newspapers reading "100 barrels of V.B. Beer and other household necessities for sale." A country where beer is considered a household necessity should appeal to every foundryman.

* * *

What New Guinea does possess is gold mines, which are situated on a plateau in the centre of the island, with no road to reach them. So far all communication is made by aeroplane, but the prospectors have been contributing for a long time to funds for the building of a road, which fails to materialise. What virginal soil for the many inventors of new road surfaces, who do not seem to get a look in here!



Unetched. Etched.

The photomicrographs above appeared in a recent issue of the Bulletin of the American Society for Testing Materials. It looks as if a spiritualist had been at work photographing what he foresaw at the London Congress—and one wonders which particular cat was destined to be let out of the bag. "Marksman."

Beyer, Peacock & Company, Limited, Gorton, Manchester, have obtained an order from South Africa for 16 Beyer-Garratt articulated steam locomotives.

International Association for Testing Materials

CONGRESS HELD IN LONDON

The opening Plenary Session of the London Congress of the International Association for Testing Materials was held in the Grand Hall of the Institution of Civil Engineers, Great George Street, Westminster, on April 19. Sir William Bragg, O.M., K.B.E. (President of the Congress), occupied the chair, and was supported by Sir Frank Smith, K.C.B., C.B.E. (chairman of the British Executive Committee of the Congress), and Dr. H. J. Gough, F.R.S. (President of the International Association for Testing Materials and chairman of the British Committee). There was a very large attendance.

Message from H.R.H. The Duke of Kent

The President read the following message which had been received from H.R.H. the Duke of Kent, Patron of the Congress:—

"I shall be very grateful if you will express to the Congress now assembled under your presidency my deep regret at not being able to be present in person at your opening meeting. I should like to say how pleased I am to know of the presence of so many distinguished visitors from the twenty-five countries represented, and I should like you to convey to them my cordial wishes for a successful outcome of their deliberations."

Sir William Bragg, O.M., K.B.E., Pres. R.S.
(President of the Congress).

The President, continuing, said he was sure that it would be the wish of the meeting that a grateful answer should be sent to His Royal Highness, and the secretaries would arrange for that to be done.

Welcome to the Members of the Congress

The President welcoming the members of the Congress, said that it was his duty, and a privilege which he valued very greatly, to open this, the Second Congress of the International Association for Testing Materials. It would be recalled that the First Congress was held in Zürich some six years ago. At that meeting the British representatives proposed that the next Congress should be held in London; they were, he thought, inspired by the example of their Swiss hosts, whose hospitality was still a memory to all the members of the Zürich Congress. They were anxious in this country to show what they could do, and to entertain their visitors to the best of their power; they had themselves received so much hospitality from other countries which they had visited, and had such pleasant memories of those visits, that they were very anxious to show their gratitude for what they had received. On behalf of Great Britain, therefore, he wished to bid all the members of the Congress, and especially those who had come from abroad, a very warm welcome.

The preparations for the Congress had been made by an enthusiastic body of workers in this country, and he knew that the Congress, as a whole, would feel indebted to Dr. Gough, to Sir Frank Smith and the other members of the Committee, and especially also to Mr. K. Headlam-Morley and Mr. G. H. Ford, who had done so much to make fitting preparation for a Congress of such importance. Nor should there be forgotten the good service which had been done by so many abroad, and especially by the Presidents of the four Groups, Prof. Benedicks, Prof. Suenson, Dr. Barta and Prof. Rabozée.

In this country the work of the Congress was especially appreciated. The title of the Association seemed to him to convey a somewhat imperfect sense of its real value. It dealt with more than the mere testing of materials for use; it considered besides that the behaviour of materials and their nature, and its work ranged from the purest science to the most empirical tests, covering a very wide range indeed. People in this country had become more aware in recent years of the value of that work, and, in consequence, it would be found that many associations in this country—research associations, industrial associations and so on—were taking a great interest in the work of the Association and were very anxious to know what the results of it would be.

It remained for him only to wish the Congress a most successful meeting and to assure the members that their welcome was warm and unrestrained. He hoped that they would have a very happy time, and that they would be able to contribute considerably to the progress of those subjects which they all had at heart.

Sir Frank Smith, K.C.B., C.B.E. (Chairman of the British Executive Committee of the Congress), on behalf of the British Executive Committee and of all the British Organising Committees, extended a very hearty welcome to all those attending the Congress. For many months past, he said, the members of the Committees in this country had been working most assiduously and most carefully to ensure the success of the Congress, to ensure that it would be a great success technically, a great success from the excursion point of view, and also a great success from the entertainment point of view. He was sure that those who had read the two hundred odd titles of the Papers which had been communicated to the Congress would at least be convinced that from the point of view of quantity the success of the Congress was assured. From the point of view of quality also he felt certain that success was assured, but the definite answer there could not be given until the end of the Congress.

Mr. K. Headlam-Morley (Hon. Secretary) then read out the names of the countries represented, and their representatives were greeted with applause on coming to the platform to shake hands with the President, Sir Frank Smith and Dr. Gough.

Dr. H. J. Gough, F.R.S. (President of the Association), said he wished to make it clear in the first place that he was not speaking as the representative of any country, but as President of the Association and on behalf of the Permanent Committee. His first duty on behalf of the Association was to thank Sir William Bragg, the President of the Congress, and Sir Frank Smith and the members of his Committee for the invitation given to the Association to visit this country, for the many arrangements they had made to welcome the members of the Congress, and for the generous way in which they had expressed their welcome that morning.

He did not intend to delay the meeting by giving a history of the Association, but he would like to remind the members that the Association, as an international body, had had a fairly long life; it dated back to about the year 1885, and it was associated with the name of Bauschinger, who was regarded in this country as the Prince of Investigators. The records of the Association and its publications dealt with many illustrious researches in physics, in engineering and in metallurgy, contributed by men of eminence in the subjects with which they dealt.

The first alteration in the main character of the activities of the Association occurred in 1927, and he mentioned it because he thought an important lesson could be learned from the reason for it. The alteration was made because it was recognised that international standardisation should not be a feature of the work of the Association. Under the revised statutes, a most successful Congress was held in Zürich in 1931, and at that meeting the British representative, who at that time was Dr. Walter Rosenhain, extended an invitation on behalf of this country for the next Congress to be held in London. At that time it was hoped that the Congress could meet in London about the year 1934, but at the very moment when the Zürich Congress was concluded, what was called the economic crisis fell upon Europe, including this country, and it had a very great effect upon the history of the Association, particularly with regard to its finance.

Dr. Herbert J. Gough, F.R.S.
(President of the Association and Chairman of the British Committee).

Among the work carried out on behalf of the Association during the last five and a half years was that of the so-called Study Commissions, which were set up with the object of looking into various problems. There had been ten such Commissions since the Congress in Zürich, and, as a result of their work, the Permanent Committee, at its meeting on Saturday last, received reports on the following subjects:—(1) Notched bar testing; (2) cast iron; (3) concrete and reinforced concrete (several aspects); (4) Portland cement; (5) viscosity; (6) fuels and fuel analysis; (7) wood; (8) methods of calibrating testing machines; (9) terminology of mechanical properties. The Permanent Committee had decided to take no direct action with regard to those reports, but to refer them to all the National Associations represented on the Permanent Committee. The only action which he need now take was on behalf of the Association and its Permanent Committee to thank the Presidents of those Study Commissions and all the members, who had worked so hard.

Prof. Dr.h.c. A. Portevin (France) (Vice-President of the Association), who spoke in French, said he was happy to have the honour of conveying, on behalf of the French Association for Testing Materials and on behalf of all the French-speaking members of the Congress, their cordial greetings and sincere congratulations to the eminent President of the Congress, Sir William Bragg, and to the

President and members of the Organising Committee of the Congress. The remarkable programme which had been drawn up and the number and importance of the contributions from those best qualified to deal with the various subjects in the whole world were a guarantee of the success of the Congress, and he wished to thank and to congratulate the organisers of the Congress and the Presidents of the Groups on what they had achieved.

Prof. Dr.-Ing. P. Goerens (Germany) (Vice-President of the Association), who spoke in German, expressed the pleasure of the German members at being able to attend the Congress and to hear the interesting speeches which had so far been delivered. On behalf of the German delegation, he would like to thank all those in Great Britain and other countries who had done so much to make the present Congress a success.

Prof. Goerens, continuing, said he had been asked by the National Association in Germany to extend an invitation for the next Congress to be held in Germany.

Dr. H. J. Gough, F.R.S. (President of the Association), on behalf of the Association and its Permanent Committee, thanked Prof. Goerens most sincerely for his cordial message of greeting, which was greatly appreciated, and expressed the pleasure felt by the Congress at the presence of Prof. Goerens and his colleagues from Germany. With regard to the very cordial invitation which Prof. Goerens had brought with him from Germany, he was authorised to say that the Permanent Committee accepted that invitation with great pleasure, and he would like to thank Prof. Goerens very much for the way in which he had delivered that invitation.

Quite apart from the invitation to hold the next Congress in Germany, the Permanent Committee, at its meeting on Saturday last, decided unanimously to ask Dr. Goerens to accept the Presidency of the Association at the conclusion of the present Congress. On behalf of the Association and of the Permanent Committee, therefore, he extended to Dr. Goerens a very cordial invitation to accept the Presidency of the Association at the conclusion of the present Congress and until the time of the next Congress.

Professor Dr. Ing. P. Goerens, speaking in German, thanked the Permanent Committee for the great honour which they had done him, and said he accepted their invitation with much pleasure.

Presidential Address

The President of the Congress (Sir William Bragg), in the course of his presidential address, said that a Congress with a membership of more than 600 and an overflowing list of communications was clearly an affair of importance. Its title scarcely indicated the extent of its activities. The "testing of materials" might seem to refer only to the mechanical tests required by trade and industry. But the Congress dealt also with the nature, properties, and treatment of all the materials used in the work of construction: and as the world was in a constructive mood, this covered a large proportion of the nations' activities. Its considerations ranged from the purely scientific analyses of metals, cements, fibres and so forth to the merely empirical tests to which industrial materials were submitted. Thus the Congress might be considered to represent the technical progress of the world.

The examination of materials might be said to show three phases. To the first might be assigned the examination of materials in bulk, such as the tests of the strength of materials used in the factory, in the shipyard, during construction of all kinds. A number of the Papers submitted to the Congress dealt with questions of this kind, which must always be of fundamental importance. The tests changed their character with the times, and reflected the progress of technique. Thus the present-day constructions required that metals and alloys should be made to stand at high temperatures all the strains that fifty years ago were required at low temperatures only. At high temperatures the effects of corrosion were increased greatly, and this introduced new devices and new tests.

A second phase covered the attempts to refer the behaviour of substances to their internal structures. All substances were granular, and their properties depended on the action of each grain upon its neighbours, and further upon the action of every atom upon the atoms that surrounded it, an action which went very little beyond the atoms that were closest.

Continuing, the speaker said the use of the microscope in metallurgy was one of the first factors in demonstrating the need of examining the grain-like appearance of a metal; the metal industries had profited enormously by this advance. But the microscope did not go deep enough; the light which the eye could see was too coarse to show up the atoms and molecules which were the basis of the structure and the fundamental cause of its properties. Hence the eager application of the new X-ray methods, which succeeded where the microscope failed. The many Papers submitted to the Congress which dealt with these new matters showed the importance attached to them.

Modern observations were continually emphasising the importance of the state of the surface of a body. The very few layers of atoms on the outside had a predominating influence on such effects as corrosion, wear, catalytic action, and physiological action in living organisms. The X-rays penetrated too deeply to show conveniently the state of these extremely thin layers, much less than the millionth of an inch in depth—and yet so important. At this point the very new methods of electron diffraction proved their value, and Papers on that subject were among the most interesting of those in the agenda.

In a third phase of the examination of materials, said the speaker, might be placed the stupendous task of accounting for the behaviour of substances in terms of the atomic forces, a task which, of course, became possible only when the structures had been correctly mapped out by all the new methods of observation. This phase was also represented by Papers submitted to the Congress. Thus the whole business of learning how to use the materials of the world to their best advantage was very much alive. The Congress met at a time when the importance of the understanding of the relations between structure and behaviour was more and more appreciated. Its deliberations and consultations are of primary importance to industry, and also to the industrial collaboration of the nations.

Prof. Dr. M. Ros (Switzerland), speaking in French, said he had the honour to convey the homage and profound gratitude of the International Association for Testing Materials to Sir William Bragg for having been good enough to accept the duties of President of the London Congress and for having presented his magnificent report, the first of the Congress. It was to Sir William Bragg that was due the foundation of the science on the fundamental structure of crystals, his classical researches on crystal structure, the numerous works of his school, and the method of the quantitative determination of the arrangement of atoms in crystals, both with regard to its experimental form and with regard to its theoretical bases. He would ask Sir William Bragg to accept his simple words as the testimony of the highest esteem, of admiration and of profound gratitude.

The President thanked Prof. Ros sincerely for his kind words of appreciation; the meeting adjourned until the closing Plenary Session, which was held last Friday.

OFFICIAL BANQUET

The Official Banquet of the Congress was held at Grosvenor House, Park Lane, London, W.1, on Tuesday, April 20, Sir William Bragg, O.M., K.B.E. (President of the Congress), occupying the chair. More than five hundred members and guests were present.

The Rt. Hon. Lord Eustace Percy, P.C., M.P., proposing the toast of "The International Association for Testing Materials," said the Association was engaged in perhaps the most practically important work in which any international body was engaged at the present day. We lived in one of those periods of the world which seemed to be great constructional periods. As in the Roman Empire and as in the Middle Ages, so now the whole of civilisation seemed bent on enormous and deliberate works of construction. In the nineteenth century, in the heyday of the dawn of the Industrial Revolution, building programmes—programmes of housebuilding and shipbuilding, programmes of road building and so on—were practically present, but it was the mere exuberance of youth; there was very little deliberate planning or construction. To-day we had deliberately set ourselves to build, to conquer not only the land and the sea, but the air, and to construct up to the limits of possible human achievement.

The speaker proceeded to ask if his analogy with the great constructional periods of the past, with Imperial Rome and the cathedral-building Middle Ages, was ominous. Were we perhaps in danger of experiencing that fate which seemed to have dogged all these great constructional periods, the fate of somehow missing the human and the imponderable, and collapsing in ruin owing to the failure properly to assess those factors in human happiness and human prosperity? It was not perhaps out of place, at a great international gathering such as that, to suggest that those who were gathered together from all the nations to exchange knowledge and to advise on certain practical and measurable problems should also use the opportunity to consider those less measurable problems and forces which might undo, which might make or mar, all their scientific work.

Dr. H. J. Gough, F.R.S. (President of the Association), who responded, said that, in endeavouring to reply to the toast, he should like to speak not so much about what the Association was supposed to stand for as about what he believed it could stand for much more usefully than the mere technical objects. According to the printed rules, they were supposed to attempt to secure international co-operation, exchange of views and experience and knowledge, regarding materials and their testing. Those, of course, were mere technical objects, but he himself believed that the chief object of such meetings as that was a very much wider one. He believed that, as a result of that and similar meetings, they could get to know and understand each other very much better.

Continuing, the speaker said it would be the wish of all his colleagues on the Permanent Committee that he should make some reference to their late President, Dr. Walter Rosenhain. His brilliance was undoubted, and all who knew him were aware that his zeal for and interest in international co-operation through that Association were immense. Unfortunately, they had lost him; otherwise, he would be occupying the position which he (the speaker) now occupied.

The speaker, referring to the invitation from their German colleagues to hold the next Congress in Germany, said he should like to take this opportunity publicly to assure their German friends how very much they appreciated that invitation. Under their statutes, the next Congress could be held in three years' time, and they looked forward to going to Germany in 1940.

Prof. J. O. Ross-af-Hjelmsater (Sweden), proposing the toast of "The Congress," said that a congress was an organism that lived a short but intense life. Most of those present were, in their technical and industrial occupations, investigating and wrestling with problems in connection with the testing of materials. They tried to do their best: they studied as well as they could the immense flood of communications from their co-workers in other countries, and sometimes they felt able to add to it themselves. They tried to lift their work from the empirical stage to the highest state of a science; but, though great progress had been made in many directions, they were often compelled to realise how little they knew and how many problems were still unsolved. At that Congress they were able to survey the knowledge on many important problems presented by able investigators from many countries, and they felt a community of interest and the encouragement of mutual efforts.

The President (Sir William Bragg, O.M., K.B.E.), replying, said he had heard a great deal as to the value of the Papers which had been read, and he had observed the very large attendances. Various speakers had said that a Congress of that kind was of real value in other ways than the production of Papers, and that was certainly true. The opportunity provided for people to meet one another was of great value. He thought that a Congress such as that could perhaps be at the present day one of the most useful means of bringing about a better understanding in the world and making for world peace.

Sir William Larke, K.B.E. (Director of the British Iron and Steel Federation; vice-chairman of the British Executive Committee of the Congress), proposed the toast of "The Visitors."

Mr. R. L. Templin (U.S.A.) and Dr. Ing.e.h. E. Seidl (Germany) replied, while Dr. Ing. E. B. Wolff (Holland) proposed the toast of "The President," who briefly responded.

The Closing Session

A plenary session was held last Friday at which the group chairmen summarised the various views put forward, and the various officers were cordially thanked for the efforts they had made to ensure the success of the congress.

Pig-Iron*

By R. C. TUCKER, M.A.

From the Ironfounders' Standpoint

From the earliest times the ironfounder has used pig-iron and made good castings from it, and the foundry industry has built up an empirical method of assessing the properties of pig-iron by examination of its fracture and the way it broke when struck by a pig-breaking hammer. By experience simple and general rules were established by the foundrymen that open pig generally gave soft machinable castings; tough pig gave castings which resisted shock and so forth. When dealing with cold-blast and semi-cold-blast irons, these rules gave results which were satisfactory to the engineer of those days, although cast iron obtained the unenviable reputation of being a weak, brittle and unreliable engineering material. Specifications rarely asked for more than 10 or 11 tons per sq. in. tensile strength. For the founder who makes ordinary engineering castings only, those rules are still applicable, but the majority have been forced by competition, and the wider knowledge of the possibilities of cast iron amongst engineers, to improve their product and control its manufacture at every possible point. This Paper will deal with modern methods of assessing and controlling pig-iron—the principal raw material.

Evaluation of Properties

One must first endeavour to find a yardstick by which to assess the value or properties of pig-iron. This problem is associated with the metallurgical tests applied to final castings. Castings must be sound, free from sinks, draws or blow-holes, machinable, dense, sometimes pressure-tight, sometimes wear-resisting, and the metal must have certain physical properties such as tensile and transverse strengths, toughness, hardness and so on.

When pig-irons are melted in a cupola, they tend methods, one is immediately impressed by the differences in fracture that can occur, from the open, coarsely-crystalline fracture of No. 1 hematite through a multitude of gradually finer fractures to mottled and white, hard, brittle irons.

When pig-irons are melted in cupola, they tend to reproduce their characteristics of grain and toughness in a slightly finer degree, and on these grounds the idea of heredity in pig-irons has been evolved. When the scientist or the chemist was called in to help to reduce some of the variables met with in foundry practice, he immediately set to work to analyse the various pig-irons and cast irons and found that silicon seemed to be the controlling factor in determining the fracture of pig-iron. White pig-irons were generally low in silicon and open grey pigs were much higher. He also found that one to one and a-half per cent. of phosphorus gave brittle, weak pig-irons, while low-phosphorus irons (hematites) were much more difficult to break.

Chemical Analysis and Strength Specifications

From this beginning has grown up an entangling mass of chemical specifications which the founder has to meet or by which he seeks to control his product. He in turn has demanded that pig-iron shall conform to certain chemical specifications. In general principle these chemical impurities in pig-iron exert an influence on the structure and strength of cast iron, but so many other factors influence it—cooling speed, melting conditions, non-metallic impurities and the like—that chemical analysis *by itself* can be either not helpful or, at times, even misleading. Hence, the author is being compelled to build up cupola charges on a knowledge of previous physical results rather than on a purely arithmetical blending of different percentages of silicon, phosphorus, etc.

In other words, when a strength specification is desired one must burden on strength figures taking the chemical analysis into consideration but in its proper place. The conclusion is reached therefore that fracture and analysis alone are not the only tests required from engineering and special-purpose cast iron, and therefore they are not sufficient for the raw material, pig-iron. They are, however, necessary. It is also necessary when ordering a new lot, grade or brand of iron to know, first of all, what are the properties required in the final casting. From this one must decide on the approximate highest limit in price for the iron at spout. Is there 50 per cent. or so of foundry return scrap that has properties tending towards the properties required? Then, what type of pig-iron must one buy? Having decided whether the iron must be (*a*) fluid, (*b*) soft, (*c*) tough, or (*d*) strong in tensile or transverse, and having the section of the casting always in mind, one selects a brand that is known by experience or reputation to have the general properties desired. Then, and only then, is chemical analysis considered.

From the furnace stock sheet supplied by the salesman, the buyer should select a grade which

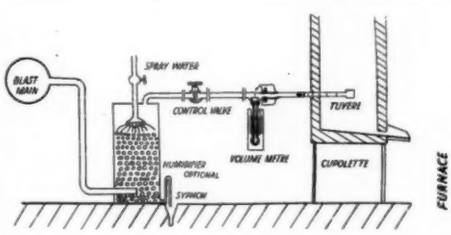


Fig. 1.—Apparatus to Control the Blast Supplied to a Cupolette.

the furnace makes in normal running. "Freak" or "odd" lots spell danger in the future and should be avoided. These grades may be numbered:—

No. 2 open soft machinable light sections, weak; close soft machinable light sections, weak.

No. 3 open soft machinable, slightly stronger, fluid; close soft machinable, slightly stronger, fluid.

No. 4 open, machinable, strong, fluid, fairly tough; close, machinable (heavy section), strong, fluid, sinking, tough, but inclined to chilled edges.

Fracture

It is important to note that fracture is absolutely no guarantee of analysis. Dr. A. L. Norbury has published curves illustrating this point showing the wide variations in silicon and carbon which give a No. 4 fracture.* The grade which meets the requirements is ordered in a sample truck and tests carried out on it. The properties of pig-iron are complex, and for rigid control a complicated system of testing should be carried out. First of all, melting procedure should be controlled. It is important that all tests should be carried out under the same conditions and it is the control of these conditions that causes the complications. The system of control advocated is only necessary when changing from one mixture to another or from one pig to another or from one brand of coke to another, or when a lot of (*a*) scrap, (*b*) pig-iron or (*c*) coke appears to be different. The apparatus—a cupolette—when built, can be started up very quickly, and in an hour or so complete information about a proposed mixture is available. In most foundries it can be used to save its cost for small melts of special iron, and in any case it will be a profitable investment. The size and design of a test cupolette should be a matter of national standardisation so that interchange of useful information is facilitated.

A recent Paper* by Guy Hénon gives much useful information about these little furnaces. Blast can be tapped from the blast main of the "all-day" cupola through a sensitive reducing valve.

A Typical Test

The furnace is fettled and rammed and dried out. The coke is selected by screening cupola coke (one brand only), and using only that portion which passes a 2-in. screen and rests on a 1-in. screen (for a cupolette of 15 in. dia.). The bed is made up over a wood fire and allowed to burn through. Blast is then turned on until the bed is white hot and is then shut off. The bed is then carefully made up to a constant gauge and the cupolette charged. The pig-iron and scrap are broken up small (balled if necessary) to avoid sticking and channelling. The constituents of the charge are carefully weighed beforehand to facilitate quick charging. With the carefully-sized coke specified, the charge coke can be charged by volume from a wooden box, known to contain the correct weight when level-full. The blast is turned on and quickly adjusted to standard volume by means of a reducing valve and a simple volume controller.

Between the reducing valve and the tuyeres is a diaphragm and differential U pressure gauge (Fig. 1). The blast control is most important. The constant humidifier is a refinement required more in America than in British climate, but is inexpensive and does remove one possible cause of variation. The humidifier consists of two oil drums welded together. The interior is filled with sized coke (1 to 2 in.). A water spray runs counter current to the blast and is automatically drained off through a siphon at the bottom. The mains temperature varies very little in this country, and the device will ensure that blast of approximately constant temperature and 100 per cent. humidity is delivered. The differential U pressure gauge is connected across the diaphragm, and the difference in height varies with the velocity of the air along the main (or volume). As soon as a suitable volume for the cupolette is found, it can be maintained absolutely constant by reference to the U tube and adjustment of the reducing valve. It is not necessary to know the actual volume if this is kept constant.

The cupolette is kept full and the first 50 lbs. or so (two charges) are poured. Then tests for (*a*) temperature at the spout by an optical pyrometer; (*b*) fluidity at the spout by the spiral test; (*c*) and (*d*) fluidity at the casting temperature by the spiral test and the optical pyrometer respectively; (*e*) shrinkage by the A.F.A. cylinder standard; (*f*) mechanical strength (S.M. & L.), both dry and green; (*g*) and (*h*) chill and wall thickness by using a step casting; (*i*) contraction by the Keep test are made.

A shank, preheated by the first metal and holding two complete charges, should be used. If possible, small castings sensitive to sinking and drawing should be poured as well, and, if satisfactory, passed to the fettling shop as production. In this way small amounts of metal are melted under controlled cupola conditions without contamination and all necessary information can be obtained not only for the pig-iron but its behaviour when melted with steel and scrap, if this be contemplated.

On the test-bars tensile and transverse tests are carried out, and for this purpose it is advisable to skin-machine the transverse test-bar and

* A Paper read before the Sheffield Branch of the Institute of British Foundrymen, Mr. Roxburgh presiding. The author is metallurgist to Newton, Chambers & Company, Limited.

* "The Fracture of Pig-Iron and Cast Iron," by Dr. A. L. Norbury and E. Morgan, M.Sc., Foundry Trade Journal, June 11, 1936, p. 453.

* "The Baby Cupola," by Guy Hénon. Translated in the Foundry Trade Journal, September 10, 1936, p. 201, from "La Fonte."

eliminate surface defects. Routine bars usually do not warrant machining.

This is the only reliable method of assessing the value of a new pig-iron. Truck to truck control can then be carried out by chemical analysis and examination of the fracture.

Toughness Determination

The toughness of cast iron is a property which it is very difficult to measure reliably and quantitatively. There are at present three general tests for this property:—(1) Pig-breaking hammer, associated with pig-breaking experience; (2) Stanton repeated-impact test as modified by the B.C.I.R.A., which gives the number of blows to fracture, and (3) resilience by the transverse load/deflection curve yielding an energy of rupture figure.

Examination of these tests gives the following information:—(1) The pig-breaking hammer is traditional and common, but is not quantitative. It is also subject to the errors of industrial fatigue, prejudice and variations in pig size. (2) The Stanton repeated-impact test is almost a fatigue test, and it has been shown by the National Physical Laboratory that the fatigue ratio of a brittle iron is 1. The test does, however, classify irons into a general list, but its quantitative value is almost nil. (3) In the third method, as the load is applied slowly, no effect of velocity of impact is taken into account, and resistance to sudden shock is not measured. Pearce, Vivian and others have developed the transverse test into a complicated one, where plastic, elastic and total deflections are measured and the iron assessed on the type of curve, resilience and percentage of plastic set.

Elastic Deflection

The author has found that the elastic deflection curve is not a straight line for a good engineering iron, and Fig. 2 shows curves for this type of iron. He has tried to investigate the worth of the transverse test as a measure of toughness, and for this reason has chosen four different cupola-melted irons of varying characteristics, using 1.20 in. diameter green-sand bars. Table I shows the figures obtained.

Iron B, a hematite, is very much superior to the others in its resistance to heat-shock, as is shown by many service records, taking pig moulds and blast-furnace valves as criteria. Iron A is the worst, yet its breaking load is similar; irons C and D (which have greater resiliences) do not resist thermal shock as well as B; C is slightly better than D. The deflection at breaking load is the same for B, C and D, but the percentage plastic resilience seems to be a measure of the known relative toughness of

Table I.—*Characteristics of Four Cupola Melted Irons.*

Iron.	Load. Lbs.	Deflection. In.	Resilience. Lb.-ins.	Plasticity. Per cent.
A	1,654	0.16	145.7	18.26
B	1,650	0.215	207.7	35.4
C	2,158	0.21	244.3	26.3
D	2,388	0.21	287.4	27.0

Note.—Iron A is a common iron used for general engineering and light castings; B is hematite; and C and D are good quality engineering irons. C contained 1.6 per cent. Si and D 1.3 per cent. Si., with the other elements in similar proportions.

these irons. It is not desired to be too controversial, but it does seem that the type of shock is important and that velocity of impact or change of stress (such as heat-shock) has such an effect that the slow loading in the transverse test does not give a reliable indication of the resistance of the material to withstand shock.

A Suggested Toughness Test

There seems to be, therefore, a great need for a universal test for the toughness of cast iron. Large specimens (preferably portions of B.S. test-bars S, M and I), should be subjected to impact in a large Izod type machine. Specimens should be skin machined to remove surface defects and to ensure definite adherence to specified dimensions. In the meantime the foundry industry must be content to have a general idea of the relative toughness of different irons based on these tests.

Hurst has done very useful pioneer work in the direction of assessing pig-irons by their physical and foundry properties. It is perhaps unfortunate that Hurst's activities are so concerned with the centrifugal casting of small drums that the melting and testing methods de-

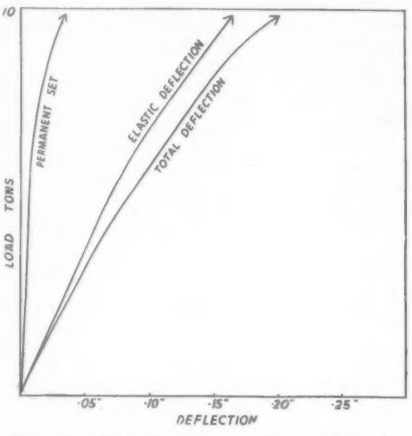


Fig. 2.—Load-Deflection Curve for an Engineering Iron. 1.2 in. dia., 18 in. Centres.

veloped by him as a standard test for pig-iron bear little relation to ordinary foundry practice.

Hurst melted his irons in a crucible furnace under unstated controlled conditions, and cast the iron into centrifugally cast drums from which test rings were afterwards machined and tested according to specification K46. Some of Hurst's first results were published before the Manchester Association of Engineers in 1931, and he drew the conclusion that there was no relation between chemical analysis and physical properties. These results are shown in Table II. Later Hurst attempted to duplicate the properties of cold-blast iron by blending raw materials on the basis of their physical properties, first by controlling chemical analysis only and then by a combination of chemical and physical properties whereby he obtained a successful match (Table III). Some roll makers are experimenting with these refined iron "matches" in place of cold-blast and charcoal irons, but it is difficult to ascertain if the "match" is duplicated in roll life and toughness. So many factors contribute to the length of life of a roll. There seems to be no real reason why melting in air surfaces should not remove any intrinsic heredity of pig-irons and leave the effects of chemical constituents to exercise their effects unhampered by heredity, silicate slime, variable melting conditions, etc. At the round-table conference held in Chicago in 1935, it was definitely stated that, whereas, in cupola-melted malleable iron, heredity played a part, in air-furnace malleable iron the time of melting was so long that these effects were removed.

The only two authenticated cases of heredity were cited for:—(1) Cupola-melted malleable iron where iron from one furnace gave malleable castings containing a few large rosettes of carbon, whereas iron of the same analysis from another furnace in the same city gave malleable iron which cast with the desired large number of small rosettes. (2) The other case was in connection with single cast piston rings which were to a rigid specification for Brinell hardness and machinability. Some pig-irons gave results consistently outside specification and others of the same chemical analysis gave the desired figures.

The author personally has only met with one case where heredity definitely caused a difference in the quality of cast iron. In one of his standard iron mixes a certain brand of hematite pig-iron is present to the extent of about 40 per cent. In 1931 his firm carried out a trial on the blast furnace in an attempt to make hematite iron for the local ingot-mould trade. An expensive high-grade Cumberland ore was used. Costs being excessive, the trial was a fairly short one and the author then had to use up the various kinds of iron that had been made. Naturally, the first lot was that possessing the same analysis as the brand of hematite being bought, and it was consistently noticed that when using "Thorncliffe" hematite made from West Cumberland ore, the tensile strengths of 1.2-in. diameter green-sand bars cast daily from this mixture were increased by over two tons per sq. in. On the other hand, recent experiments on the resistance of hematite castings to heat-shock showed exactly the same high degree of resistance with pure West Coast hematite as with a much cheaper mixture of East Coast hematite and ingot-mould scrap, using a 50:50 mixture. The actual analyses were as follow:—

	A.	B.
T.C	3.60	3.60
C.C	0.74	0.72
Si	1.78	1.90
Mn	0.98	0.65
S	0.078	0.062
P	0.15	0.14

It will be seen, therefore, that one must be guided by experience and experiment.

The founder to-day has so many ways of modifying the properties of his irons—superheating, alloying, inoculating, steel additions, controlled melting—that the intrinsic properties of pig-irons are becoming of less importance. Coupled with this is the gradual standardisation of the blast-furnace industry to coke fuel, high blast temperature, rapid but controlled melting and so on that the old regional variations are somewhat dying out. As long as the effect of phosphorus on brittleness and fluidity is taken into account, the only difference one can be sure of to-day is that cold-blast iron is tougher than ordinary hot-blast iron as shown by the pig-

Table II.—*Properties of Irons Melted under Control Conditions (Hurst, 1931).*

	Tensile strength.	Elongation.	Resilience.	B.H.N.	T.C.	Si.	Mn, S, P.
a	29.0	18.6	38.4	320	3.4	6.5	Same
b	28.8	18.5	70.2	226	3.46	3.76	
c	28.4	18.6	56.0	255	4.4	2.65	
d	20.1	16.7	33.0	228	3.49	2.86	

In *b* and *d* difference in Si does not account for difference in resilience.

Table III.—*Matching Cold Blast Pig-Iron (Hurst).*

	C.B.	1st attempt.	2nd attempt.
T.C	3.55	3.70	3.62
Si	1.83	1.95	1.96
Mn	0.87	0.95	0.90
S	0.05	0.029	0.042
P	0.48	0.51	0.50
Ni	Nil	Nil	Nil
Cr	0.05	0.026	0.031
Tensile	20.6	16.5	21.6
Elongation ..	18.7	13.5	17.9
Resilience	20.6	14.4	19.8
Brinell hardness ..	215	207	207

hammer test, but that this toughness can be equalled and more easily controlled by an addition of 1 per cent. nickel to a 1.3 per cent. silicon melt is shown by the load/deflection curves. No opportunity has occurred of adding 1 per cent. nickel to a low-silicon cold-blast melt, but it is obviously an expensive mixture.

Hence to-day the heredity difference between different hot-blast irons of the same analysis is practically nil, and nearly all variations noticed (drawing, hardness, stiff melting, etc.) are most conveniently rectified on the foundry floor and cupola where they probably originate. At the round table conference, Chicago, 1935, this point of view was also expressed by a prominent user (Mr. E. L. Clair, Toledo Furnace Plant, Interlake Iron Corporation) and maker of pig-iron. That gentleman has carried out extensive research into improving pig-iron after it leaves the blast furnace by controlled cooling conditions on the pig-casting machine.

The Blast-Furnace Aspect

Pig-iron is made in a tall shaft furnace from iron ore, flux and fuel. The blast furnace is divided into four zones. The shaft is a zone of preparation and preliminary reduction to pure iron by carbon monoxide in the gas. The bosh is a zone of slag fusion and of reduction by solid carbon of the residual iron oxide, manganese, phosphorus and silicon. At the tuyere zone the blast enters and burns the fuel with the evolution of heat necessary to promote these reactions and melt the iron and slag. In the hearth the molten iron drips through the slag layer and collects as a separate fluid layer.

At the top of the bosh, experiments by water-cooled sampling tubes have shown that some 80 per cent. of the iron is reduced to a finely divided metallic sponge but has not taken up any impurity with the exception of a small amount of carbon. Therefore any individuality is given to the pig-iron in the bosh and hearth. If the blast temperature or the relative amount of coke is increased the temperature at the tuyeres and just above them is also increased and this is accompanied by an increased silicon reduction. Thus hearth temperature determines the amount of silicon.

Carbon is not easily controlled but is absorbed when the molten iron drips down over red hot coke. Hence rich ores which usually contain low phosphorus, allow a greater chance of the iron coming into contact with carbon rather than slag, so that hematite irons are usually high in carbon.

Silicon reduction into the iron repels absorption of carbon (they are mutually repulsive but silicon reduction is controlled by temperature), and therefore high-silicon iron contains less carbon than low. On the other hand, if the furnace be working really cold, the silicon and carbon contents tend to fall, but slag fluidity is reduced so that sulphur content rises rapidly.

When a hot blast was introduced a great saving in fuel consumption resulted. With hot blast, the combustion zone is reduced owing to the greater speed of reaction between the hot air and coke.

At the same time, however, reduction times, *i.e.*, outputs, were increased, and for the same reason hearth diameters were increased. Narrowing down of the combustion zone has led to a much higher tuyere zone temperature, but a lowering of the temperatures higher up the bosh. Thus reduction of silicon and carbon occurs in a much quicker time, rising to a much higher final rate. The net result, however, is the same. In the old furnaces, the combustion zone must have extended to the centre of the furnace and well up into the bosh (Fig. 3). Modern experiments have shown that all the air is burned to $CO + N_2$ within 50 in. of the tuyere nose, so that one obtains a large inert body of hot coke in the centre of the furnace. This is known as the "dead man" and serves to support the weight of a considerable proportion of the furnace charge. Previously this was accomplished by the use of comparatively long flat boshes (Fig. 3).

Due to the large outputs furnaces are now tapped more frequently, so that the iron does not lie for such long periods in the hearth. The precise function of these different changes is difficult to assess as they have all developed together, but the result is that hot-blast pig-iron is more brittle than cold-blast iron.

The Pig-Casting Machine

Another most important development is the pig-casting machine which, used successfully for many years abroad, is at last coming into its own in this country. Fig. 4 shows the silicon variations which can occur in a furnace melting foundry iron. The present method of meeting the foundryman's requirements is to sample the cast at two to four different points and to divide the cast into four sections. With a pig-casting machine the iron is run into one ladle and is thus mixed. The whole cast is therefore of uniform composition.

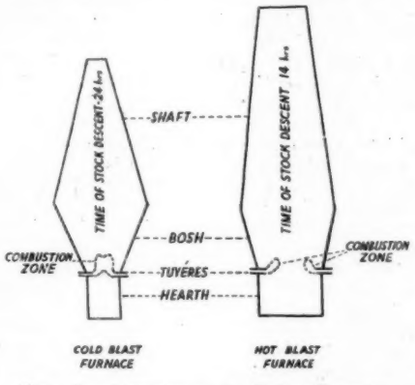


Fig. 3.—Alteration in Blast Furnace Design with the Introduction of the Hot Blast.

Time is allowed for dirt and slag to rise to the surface and the pig-iron is then run into the cast-iron moulds where it is chilled and then quenched by water sprays. The iron is free from sand and slag and is therefore very much cleaner to melt in the cupola. Less limestone is necessary and better heat exchange is obtained between the hot cupola-gases and the clean metallic surface of the iron. The only thing to which the foundryman can possibly take exception is that classification by fracture is rendered more difficult because the rapid cooling closes up the grain of the pig-iron.

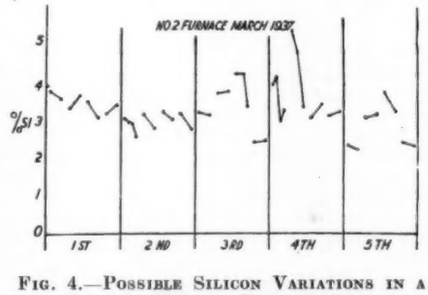


Fig. 4.—Possible Silicon Variations in a Furnace Melting Foundry Iron.

The fear that this closening of the pig-iron fracture will lead to hard castings, sinking, drawing, etc., is unfounded because the iron, if allowed to solidify in a sand mould, would have its "normal" fracture and therefore is naturally open.

The graphite nucleus theory of heredity is no longer tenable since Piwowarsky and others showed that when open pig-iron is only partly melted and quenched the molten iron contains no free graphite. The cause of open fracture is some much more fundamental property, such as (according to the B.C.I.R.A.) non-metallic inclusions which are unaffected by an artificial quench. The iron will again solidify open if it is remelted and cast in sand.

The silicate slime theory of graphite precipitation as developed by the B.C.I.R.A. gives some idea as to a possible cause for the difference in properties of hot-blast and cold-blast irons. In a blast furnace the manganese/sulphur ratio of S per cent. × 1.7 + 0.3 per cent. = Mn necessary to neutralise sulphur does not hold good. When a blast-furnace slag runs low in lime, sulphur mounts rapidly to 0.1 per cent. Even when manganese is above 0.9 per cent. this is sufficient to close up the fracture of a 2.5 per cent. silicon iron.

Charcoal irons are made with a relatively acid slag, due to the low sulphur content of the fuel and ore, and are much closer than either cold-blast or hot-blast irons of the same silicon content, even though the carbon content be very high. This is due to the fact that these acid slags have lower melting points than the normal slags and are thus more likely, when present as residual inclusions in the iron, to have the fluid surface postulated by Dr. Norbury. The difference between cold-blast and hot-blast irons may be explained by the fact that in the old and new furnace lines, shown in Fig. 3, the oxidising zone in the cold-blast furnace (good cold-blast iron should be made in a *small* furnace) extended right across the hearth, whereas the hot-blast furnace burns so rapidly that free CO_2 or O_2 only extend 50 in. from the tuyere nose.

The greater oxidation at the tuyere zone in the cold-blast furnace gives a slag of higher FeO and MnO contents which has a lower melting point than hot-blast slags. The dissolved oxygen or nitrogen in the iron is probably responsible for the increased toughness as this cannot be explained by fracture alone, but metallurgists really do not yet know the explanation. The slag-cloud theory merely gives another angle of approach and the dissolved gas theory is a direct outcome (as is, of course, the non-metallic inclusion theory) of recent discoveries in steel metallurgy.

It is surprising, however, that aluminium added to steel gives a fine-grained tough steel, whereas it gives an open fracture to pig-iron. The parallel must therefore not be drawn too closely.

The Paper has indicated that foundrymen do not yet know much about the cause of the properties of their principal raw material, but the author hopes that he has indicated that a vast amount of interesting work remains to be done on this subject with the possible goal of being able to produce cold-blast properties under hot-blast commercial conditions.

Recent Papers by Paschke and Colclough indicate for basic irons possible radical departures from normal blast-furnace technique, using very acid slags in the furnace and desulphurising by very basic slags in a separate ladle or furnace. This gives cheaper basic iron of reasonable sulphur content, but the effect of this process on the properties of foundry iron has yet to be determined. It would appear probable that foundry iron made by this process would have something of the toughness and fine graphite associated with cold-blast and charcoal iron.

British Acetylene Association

The 36th annual luncheon of the British Acetylene Association was held yesterday at the Mayfair Hotel. It had a special interest for the foundry industry as it was presided over by Mr. L. J. Tibbenham, the chairman of the Eastlingham section of the Institute of British Foundrymen. After the loyal toast had been honoured Mr. Tibbenham presented Mr. V. A. Amodeo with a gold watch as a memento of his services as secretary of the Association. Mr. A. B. Harrower, in an extremely witty speech, proposed the health of the guests, to which Sir Harold Webb, C.B.E., replied in a light vein. Sir William Larke, K.B.E., proposed the toast of the Association to which the chairman replied.

The Brown-Firth Research Laboratories

When we received a recently-issued brochure of the Brown-Firth Research Laboratories, we felt that we could best do justice to its contents by abstracting those parts which have a major interest for the foundry industry. We wish to acknowledge our indebtedness to Dr. W. H. Hatfield, F.R.S., for the loan of the printing blocks used.

Introduction

The Brown-Firth Research Laboratories, situated as they are in Princess Street, are placed physically in the centre of the many works of the special-steel industry of Sheffield, thus facilitating very intimate contact between the research organisation and the plants with which it is its function to collaborate. The scientific staff is drawn from the various universities and technical colleges of the country.

The essential work of the laboratories lies in the consideration of scientific and technical problems arising in the operation and development of the processes and improvement, modification or utilisation of the products in which the companies are interested. It is naturally very close to the immediate industrial needs, but on the one hand fundamental scientific work is by no means neglected and on the other support is accorded to the elucidation of any major scientific problems in which the steel industry as a whole is collaborating. A considerable proportion of the resources of the laboratories are devoted to assisting in the application of the various steels amongst the consuming industries.

Despite the advances which have been made over the last decades, much work remains to be done in determining how best various engineering and other metallurgical problems can be solved, either by the present or by improved types of steel. Railway, shipbuilding, turbine, automobile, aero, textile, chemical, hydraulic and general engineering work all present problems calling for scientific treatment. Such matters as the technology of rust-, acid- and heat-resisting steels, high-tensile steels, tool steels, spring steels, file steels, non-magnetic steels, magnet steels, steels of high coefficient of expansion, steels of low coefficient of expansion, case-hardening steels, nitriding steels and special steels generally, demand scientific and technical consideration. Whilst primarily designed for the influence which they might bring to bear upon the processes and products of the associated companies, the laboratories are unhesitatingly placed at the disposal of manufacturing concerns which are utilising the companies' steels, for the purposes of assisting in the solution of consumers' own problems. The latter section of the work is extremely valuable, since it often assists the laboratories in determining the special direction which some of their investigations shall take. The results of investigations carried out in the laboratories have frequently been published and are familiar to the engineering world.

The laboratories may justly claim a share in the metallurgical developments of the last few decades. The first development of note followed from the discovery, in 1913, of the stainless cutlery steel containing approximately 0.30 per cent. carbon and 13 per cent. chromium. It was immediately realised that there would be presented an enormous field of possible application for a stainless steel possessing a still wider range of resistance to corrosion, in conjunction with certain mechanical properties. The higher chromium steels were investigated and nickel, in various percentages, was added. Thus was developed the "Staybrite" type of steel containing 18 per cent. of chromium and 8 per cent. of nickel. In response to a demand for a material for deep press work, the research laboratories were responsible for the introduction of a modification of "Staybrite" steel, namely, "Staybrite" D.D.Q. (deep-drawing quality) containing about 12 per cent. chromium and 12 per cent. nickel. The use of this steel, owing to its extreme ductility and malleability, has developed very rapidly. Subsequently a number of further modifications have been developed to meet various special requirements. With the production of these special steels arose the necessity for the development of suitable processes for their manipulation by fabricators. This aspect was dealt with exhaustively by the research laboratories and, as a result, a correct technique was developed for welding, hard and soft soldering, pickling, machining, pressing, spinning and other manipulative processes. It is of interest that the methods then evolved are now standard practice throughout the industry. It was also during the course of these researches that the well-known copper-sulphate sulphuric-acid solution was developed. This solution is now universally accepted as a standard testing solution for determining that such steels have the desirable properties. The laboratories have also played an important part in the development of the nitriding process of surface hardening steel, and in its application to the many types of steel which can now be hardened in this way.

The demand for a steel having a high coefficient of thermal expansion comparable with that of aluminium has been met by the production of a special nickel-manganese-chromium steel, which was immediately covered by Air Ministry specification. This steel also finds valuable application as a high yield-point non-magnetic material for electrical work. The researches of the Brown-Firth Research Laboratories on the subject of heat-resistant steels, possessing both resistance to scale formation and strength at elevated temperatures, are well known.

As regards armaments, problems arise of great importance and a substantial portion of the resources of the laboratories is taken up with continuous studies in this field. Such work being for the Services is not of the nature suitable for presentation to scientific and technical societies.

A research organisation must be very extensively equipped if it is to deal effectually with steels—particularly modified ones or new ones—and this will be clear from a consideration of the following:—

Data Required for the Complete Examination of an Alloy.

Chemical Analysis.

Metallographic Examination.—Macrostructure; Microstructure; Grain Size; Examination of inclusions (quantitative and qualitative).

Physical Properties.—Melting and freezing temperatures; Critical points; Specific gravity; Specific heat; Thermal conductivity; Thermal expansion; Electrical conductivity; Thermo-electrical properties; Electrochemical potential; Magnetic properties; Optical properties; X-Ray analysis.

Mechanical Properties at Normal Temperatures.—Tensile (Elastic limit, proof stress, yield point, maximum stress, elongation, reduction of area, elastic modulus, Poisson's ratio); Hardness; Notched-bar impact; Torsion (Elastic limit, yield point, maximum stress, degrees twist shear modulus); Bend; Fatigue range; Deformation tests; Wear-resistance tests.

Mechanical Properties at Elevated Temperatures.—Stability; Red hardness; Creep properties.

Mechanical Properties at Sub-Normal Temperatures.

Resistance to Corrosion and Chemical Attack (including corrosion fatigue).

Resistance to Scaling.

Response to Surface Hardening.—Carburising; Nitrogen hardening.

Effect of various heat-treatments on the above properties.

Effect of various degrees of cold-work on the above properties.

Effect of heat-treatment after cold-work.

Additional Data Required from the Standpoint of Industrial Application.

Casting.—Feeding and production problems, heterogeneity.

Hot-Working.—Applicability to manipulation by forging, drop-stamping, rolling, and other processes.

Heat-Treatment.—Response.

Machinability.—Feeds, speeds and tool angles.

Cold-Working.—Suitability to press work, stamping, punching, spinning, moulding, beading, rolling, bending and drawing.

Facility for *Welding.*
Facility for *Brazing.*
Facility for *Hard Soldering.*
Facility for *Soft Soldering.*
Response to Pickling.

The organisation of the Brown-Firth Research Laboratories, having steadily developed over the last thirty years, has continually increased its resources in all the directions necessary for adequate handling of problems in the industry.

Library

The position of the specialised library in relation to scientific research is now definitely established, an important function of the library service being to avoid duplication of research and to economise time spent in investigation. The library of the Brown-Firth Research Laboratories consists essentially of publications relating to the metallurgy of steel and kindred subjects. It has on its shelves between two and three thousand bound volumes, whilst in addition it possesses a large and valuable collection of reports and manuscripts which are classified and cross-referenced on a card index system. The proceedings and transactions of all the leading scientific and technical institutions and societies are available, whilst the library subscribes to some fifty scientific and technical journals.

Keeping in touch with contemporary investigation is a vital and difficult problem. It is often the case that the data in any standard treatise have already become out of date, as far as the research worker is concerned, even before the book is released from the press. For the latest information, therefore, the scientific investigator has very largely to rely on Papers presented before the various societies and on articles appearing in the technical Press. An important function of the library service is, therefore, that of sifting the enormous mass of published literature, and the abstracting and distribution of information so obtained to the people concerned: this work being supplemented by the systematic search of the leading abstracting systems. Obviously to obtain maximum results from this service it is essential that the persons responsible for the work must be kept in close touch with the difficulties and needs of every phase of steel metallurgy, in the production and manufacture of steel and in its subsequent life in service. Whilst nothing of value must be missed, it is equally important that valuable information should not be lost in a mass of irrelevant data. In the actual preparation of the abstracts the librarian has the assistance of the technical staff of the laboratories.

Theatre

Situated in the basement of the building is a lecture theatre and cinema, with seating accommodation for about 100 persons. It is fitted with equipment for the projection of lantern slides and standard silent films, whilst during the last few years sub-standard sound equipment has also been installed. This theatre is used for periodic technical meetings of staff, for lectures, and for

the instruction of visitors who, from time to time, inspect the laboratories or the works with which they are associated.

Experimental Steel-Making

In studying the potentialities of new compositions in steel, it is of great advantage to be able quickly to produce small quantities of the compositions to be studied, although it must always be recognised that the final test of the properties of any particular type of steel must be carried out on such material as would be obtained on a production basis: that is to say, produced in a medium- or large-sized furnace as distinct from a small experimental unit. At the same time, much valuable pioneering work has been and is being done with material produced from small-scale equipment. For many years the chief unit of the experimental plant attached to the laboratories has been an electric arc melting furnace of the 3-electrode type, having a capacity of about 30 lbs. weight. The furnace is of the tilting type and the hearth employed can be adapted to the type of steel being produced. The basic hearth, consisting of rammed dolomite and tar, has been chiefly employed.

Fig. 1.—Experimental High-frequency Melting Furnace.

More precise control, both of temperature and of the physico-chemical reactions in the bath, is obtained in a special high-frequency induction furnace of 100 lbs. capacity (Fig. 1). This furnace enables steel to be melted under conditions approximating to commercial production. In addition to these two furnaces, an electric resistance furnace of small capacity, fitted with auxiliary equipment for vacuum melting, has also been employed. From these furnaces it is usual to cast into small ingot moulds, the resulting ingots being then forged or rolled into bar of suitable size for further tests. Alternatively, steel is, on occasion, cast into sand moulds for the investigation of its properties in the cast or cast and heat-treated states.

Heat-Treatment

Heat-treatment forms a vital part of the work of the research laboratories, for in the careful study of heat-treatment lies the correct solution to many problems relating to the properties and successful application of alloy steels. The heat-treatment laboratory is fitted with furnaces suitable for subjecting small objects and test-pieces of various kinds to experimental treatments. The equipment includes gas and electric muffles, furnaces, salt and oil tempering baths, each fitted with the necessary pyrometric equipment; and oil and water quenching tanks. A very heavy burden falls on this department, and in the course of a week's work it is not uncommon for the throughput of this laboratory to be numbered in hundreds of test-pieces, each one of which is heat-treated to an accuracy which must be beyond question.

Pyrometry

The work of this laboratory consists in part of the calibration and maintenance of the pyrometric equipment used throughout the works of the associated companies. Thermo-couples—mainly of the platinum/platinum-rhodium type, but also including base metal couples—are made up in the laboratory, are calibrated, and are kept in order by frequent checking and recalibration. All the indicators and recorders used throughout the works are also under the control of this department and are repeatedly examined and recalibrated.

Optical and radiation pyrometers are used for temperatures exceeding 1,000 deg. C. The maintenance of a complete set of disappearing filament instruments for routine determination of temperatures of molten steel in the works, as well as the periodic calibration of the polarising type pyrometers used in the many forge departments, are further duties of the pyrometric department. Other activities include the determination of heating and cooling curves, the construction of electrical furnaces for use in the various laboratories, actual observations of liquid steel temperatures during the tapping and casting of heats in the works and forging temperature observations.

Mechanical Testing

The mechanical testing laboratory is fully equipped with testing machines designed to ascertain the mechanical properties of steels. These machines include Avery and Olsen universal tensile machines, Avery torsion, Wöhler fatigue, Izod impact, Charpy impact, Brinell hardness testing, Erichsen sheet testing, Stanton repeated impact testing, Sankey bend, Saniter wear testing and other machines.

For the purpose of obtaining the stress-strain diagrams of tensile test specimens, various forms of standard extensometer are available, and others have been designed and constructed in the department itself. The laboratory has also designed and constructed a lateral extensometer so that determinations of Poisson's ratio can be directly made.

Apart from carrying out tests at ordinary temperature the laboratory is equipped for carrying out tests at both elevated and sub-normal temperatures, and a wealth of data in these regions has been accumulated over a long period of years. The range of work undertaken is extremely wide, and includes, not only the testing of new alloys and compositions and the ordinary routine work of day to day investigations, but also the complete testing of certain of the associated companies' more important products, both at ordinary and elevated temperatures. In addition, special investigations are carried out in this laboratory which are of a more fundamental nature, being concerned rather with the nature and significance of the test itself than with the results of routine testing by that method.

High-Temperature Mechanical Testing

The laboratory for testing steels at elevated temperatures is situated in the basement of the building in order to avoid, as far as possible, undue vibration and changes in room temperature. The apparatus consists of a battery of machines for general purposes, the load being applied to the specimens under test by means of 20:1 levers supported on hardened knife edges. Each machine is provided with a suitable electrical resistance furnace, the temperature of which is controlled by means of iron wire filament resistance lamps. Changes in length of the specimens subjected to stress and temperature are determined by an external type of extensometer measuring to a limit of accuracy of $\frac{1}{50000}$ inch. Temperature is constant to about 1 deg. C. and is carefully adjusted to the initial temperature for each reading taken. The creep test which has been devised and adopted as standard by the Brown-Firth Laboratories is one lasting three days. By means of a series of such tests the highest stress at a particular temperature is determined which conforms to the following requirements:—(1) That the extension during the first day does not exceed 0.5 per cent. of the gauge length; and (2) that the rate of extension during the second and third days does not exceed one millionth of an inch per inch per hour. The stress so determined for any particular temperature is termed the "time yield."

Besides the above apparatus, special units of a more sensitive type have been installed. These machines are capable of measuring rates of creep approaching one hundred-millionth of an inch per inch per hour. They are strongly constructed and are embedded in a solid concrete base, load being applied by 20:1 levers. The furnaces are 24 in. in overall length, thus making provision for a specimen having a gauge length of 8 in. Each furnace, which is of the electrical resistance type, is constructed in three sections, each controlled by its own rheostat. This ensures exact uniformity of temperature along the test-pieces at any given test temperature, the temperature of the test-piece being measured by thermocouples fixed at the top, middle and bottom of the parallel portion of the specimen.

Changes in length of the specimen are measured by means of a very sensitive and modified form of Lamb's roller type of extensometer, which is connected to the parallel portion of the specimen by means of hardened knife edges suitably clamped. A scale, curved to the requisite radius, is situated at a distance of 21 ft. from the mirrors, and is viewed by reflection through two mirrors mounted on rollers, through a telescope fitted with cross wires. The rollers carrying the mirrors are $\frac{1}{4}$ in. in dia., and 1 mm. on the scale represents 0.000,005 in. extension. As readings of half a millimetre can be taken, determinations of extension can be

made of the order of one-third of a millionth of an inch per inch of gauge length.

It is obvious that for an extensometer of the above sensitivity, the temperature of the test-piece must be maintained constant within narrow limits. For this reason a sensitive thermostatic control was devised. This is essentially a Wheatstone bridge arrangement where the variable arm consists of a 0.1 mm. dia. platinum wire, of 200 ohms resistance, situated between the test-piece and the heating units, and constituting the thermostat. Any change in resistance of this wire due to temperature operates an Electroflo temperature controller having a centre zero, the relay of the controller being actuated by a chopper bar worked from a continuously running a.c. motor. The position of the needle of the indicator at the moment of action determines the switching in or out of a balancing resistance. This arrangement is independent of room temperature, and control of an accuracy as great as 0.1 deg. C. is obtained.

Actual determinations of temperature of all tests carried out in this laboratory are made by means of platinum/platinum-rhodium thermocouples connected to a high sensitivity potentiometer capable of reading to an equivalent of 0.005 deg. C.

Metallographical Laboratory

Metallography is that branch of physical chemistry which deals with the internal structure of metals and alloys. In its more limited sense this term denotes the study of specially prepared metallic surfaces, which are generally sections cut through the metallic mass. The examination may be made with the unaided eye, with the help of a hand lens or by means of a microscope. It is with this type of investigation that the metallographic laboratories are concerned.

Metallography had its birth in the reign of Charles II, and in 1665 Robert Hooke—the secretary of the then newly incorporated Royal Society of London—described, in his "Micrographia," the appearance of the magnified surface of a polished steel blade. In spite of the useful work of Réaumur and Widmanstätten, no great advance was made in this study until 1864, when Sorby, of Sheffield, passed from his study of rock slices to the microscopical examination of polished and etched sections of iron and steel. With the name of Sorby should be remembered those of the Continental pioneers, Martens and Osmond. To-day, the science of metallography is indispensable to metallurgical research.

Two laboratories are devoted to the study of crystal structure. One is equipped for macro-examination of the coarser structural features, such as the crystallisation in ingots and castings, segregation in forgings, and the direction of the lines of "flow" in forgings and stampings. Permanent records of flow-structures are made from the deeply etched surface by a direct printing process or by photographic methods, whilst distribution of sulphides is determined by the well-known method of sulphur printing which is applied to complete as well as sectioned forgings, billets and other large masses of steel. Such work as this is of inestimable value to designers of large scale highly stressed steel plant and machinery and forms an essential link between the design and forging departments.

Microscopical Laboratory

Micro-examination begins where macro-examination ends and is carried out in a different laboratory. After a preliminary examination of any non-metallic inclusions which may be present, the sample is etched in one or other of the numerous available reagents, according to the particular feature of the structure which it is required to develop. From the point of view of pure research, one of the microscope's most important functions is the interpretation of the thermal phenomena associated with the heating and cooling of alloys. In the case of the experimental steels, which are constantly under investigation in these laboratories, this is the preliminary to the determination of a suitable heat-treatment. Once this has been established, it is quite practicable to work backwards and to determine, from the microstructure, the heat-treatment to which a sample has been subjected. The microscope thus assumes the rôle of detective and it is in the investigation of the causes of failure that microscopical analysis finds its widest application.

The microscopical laboratory is fitted with the most up-to-date apparatus for carrying out the numerous processes now employed for investigating the structure of metals. The Leitz polishing apparatus is used for the preparation of most of the sections for examination under the microscope, though hand polishing is still retained where the greatest possible delicacy of touch is required. Visual examinations are carried out with microscopes optically equipped by Winkel-Zeiss. All important structures are permanently recorded by means of a Vickers projection microscope which gives direct magnifications from 3 to 6,000 diameters, and two dark rooms are provided for carrying out the photographic work.

Physical Laboratory

A knowledge of the physical properties of metals is of paramount importance in the design of structural parts, and the physical laboratory is equipped for carrying out determinations of the various physical constants at normal, subnormal and elevated temperatures Determinations of specific gravity, specific heat, thermal expansion, thermal conductivity, electrical resistivity and magnetic properties, are carried out on the various products of the associated companies and on new experimental compositions. Moreover, in special cases (*e.g.*, for magnetic properties) routine tests are made to check the quality of the works products. During a number of years, the laboratories have thus accumulated a vast amount of data and they are in a position to give information concerning the various physical properties of a very wide range of ferrous alloys and advice as to their application.

Included in the work of this laboratory (Fig. 2) is the tensile testing of fine wires and special hardness testing. In the latter connection the necessity for a means of testing the hardness of thin materials and thin skins of surface hardened articles has long been recognised, and special study has been made of this intricate subject. Many years ago, the Brown-Firth Brinell hardness tester was invented for the special purpose of testing cutlery, razor blades and similar thin sheets. More recently the Firth Hardometer was developed in this laboratory. The laboratory still controls the manufacture of these instruments and improvements are being made from time to time.

Other activities of the physical laboratory are the testing of oils, and experiments on steels exposed to various atmospheres at elevated temperatures. In this connection the development of the nitriding class of steels and of the nitriding process, on which a vast amount of work has been carried out, is of especial interest.

Fig. 2.—The Physical Laboratory.

The physical laboratories carry out work on the fatigue testing of material in strip form, on friction and seizing and other problems on which data are required for the purpose of determining the best material to use for a particular purpose or of improving the performance of the products of the associated companies.

(To be concluded.)

Publication Received

How to Cut Crucible Costs. Published by The Plumbago Crucible Manufacturers' Publicity Bureau, Room 1506, 90, West Street, New York City.

This publication is extremely well considered and authoritative, and in addition to telling crucible users how to obtain the best results from their furnaces, gives a fair quantity of technical data. We do wish that either we could think in lbs. per sq. in. and degrees Fahrenheit, or our American friends would learn to visualise tons per sq. in and degrees Centigrade. Both lose so much by these needless differences. We believe that the publishers will send copies of this pamphlet to readers making application.

Some Experiments on the Influence of Silicon, Phosphorus and Manganese on Nitrogen-Hardening Cast Iron*

By J. E. HURST (Past-President, Institute of British Foundrymen)

The experimental work described in this Paper was undertaken with the object of ascertaining the effect of the elements silicon, phosphorus, and manganese, within certain percentage ranges, on the susceptibility to nitrogen-hardening of aluminium-chromium alloy cast irons of a type known as Nitricastiron.

Silicon

For the study of the influence of silicon, six series of specimens in all were prepared. These were divided into two main series designated A and B respectively. The A series were characterised by their low total carbon content, and the mixtures were calculated to yield approximately 1.75 per cent. of total carbon. This series was divided into three sections, having chromium contents of approximately 1.75 per cent., 2.25 per cent., and 2.75 per cent., respectively, and constant aluminium contents. In each of the three sections the silicon contents were varied in increments rising approximately from 2.00 to 5 per cent.

The B series were similarly constructed and differed essentially from the A series in that the total carbon contents of the metal mixtures were calculated to yield a higher value at approximately 2.25 per cent.

The alloys were prepared by melting a mixture of refined white iron, refined chromium-alloy pig-iron, ferro-chromium, ferro-silicon, and steel scrap in coke-fired plumbago crucibles. The aluminium additions were made by means of pure notched-bar aluminium.

The specimens used for test purposes were in the form of test rings machined from centrifugally-cast drums, and the testing procedure followed was more or less in accordance with that referred to in a previous Paper by the author entitled "Some Experiments on the Nitrogen-Hardening of Cast Iron."† After casting, the castings were subjected to an annealing treatment in a gas-fired continuous annealing furnace. The duration of this treatment from the time the castings entered the furnace at room temperature until their discharge at a temperature less than 300 deg. C. was 16 hrs., the castings passing through a maximum temperature zone of 950 deg. C. in a period of approximately 2 hrs.

The test rings machined from the annealed castings were submitted to the nitrogen-hardening treatment for a period of 90 hrs. at temperatures of 500, 550 and 600 deg. C., respectively. A series of test rings was retained for the determination of the mechanical properties in the annealed condition prior to nitrogen-hardening. Hardness determinations were made, using the Firth hardometer with the diamond indenter, and the total depth of penetration of the hardening effect was measured under the microscope on polished and etched specimens.

The results obtained are set out in Table I. In the chemical analyses, the manganese, sulphur, and phosphorus were not separately estimated, and may be regarded as lying between the limits 0.6 to 0.7 per cent. of manganese, 0.08 per cent. max. of sulphur, and 0.10 per cent. max. of phosphorus.

An examination of the results assembled in the Table shows that at a nitrogen-hardening temperature of 500 deg. C. the hardness value attained is somewhat low and irregular. At a temperature of 550 deg. C. a higher hardness value of a uniform character was obtained. The hardness after nitrogen-hardening at 600 deg. C. is quite low and somewhat irregular, and at this temperature the hardness value does show some signs of falling off in the higher ranges of silicon content. At the temperatures of 550 and 500 deg. C. there is no clear evidence of any variation in the degree of hardness attained which could be linked up with the silicon content.

It is also of general interest to observe that the increment in the chromium content within the ranges examined appears to be without any very great influence on the degree of hardness attained at each of the nitrogen-hardening temperatures, and in a like manner there is no evidence that this degree of hardness is affected by the difference in total carbon content in the two series.

In the case of the total depth of penetration of the hardening effect, the results indicate some irregularities. The greatest total depth of penetration was obtained, however, with a nitrogen-hardening temperature of 600 deg. C., and at 550 deg. C. the results reveal a slight tendency towards deeper total penetration than at 500 deg. C. In spite of the irregularities the results show a distinct tendency towards a smaller total depth of penetration with increased silicon content at each nitriding temperature and for each composition. Within the range examined the chromium contents appear to have a slight influence on the total depth of penetration in that they tend to ensure a greater depth of penetration for a given silicon content. The results for the two series fail to reveal any difference which could be ascribed to the difference in the total carbon contents. The total depth of penetration results have been recorded in Table I in millimetres exactly as measured.

The photomicrographs shown in Figs. 1 illustrate the depth of penetration in the three specimens A4, A12 and A14, with silicon contents of 1.92, 3.38 and 4.98 per cent. respectively. It is of some interest to observe the extremely sharp line of demarcation between the case and the core in the specimens hardened at this temperature of 600 deg. C. At a higher magnification this line of demarcation, whilst still sharply defined, is seen to be uniformly integral with the core of the material, and this is clearly illustrated in Fig. 2. At the edges of the specimens hardened at 600 deg. C. the external surface of the case showed visible swelling and cracking. Fig. 3 is typical of the structure obtained at these edges or corners, and illustrates the pronounced nature of the crack. The sharply-defined boundary of the case and core enables the corner effect of the penetration of the hardness to be shown very clearly in this micrograph.

The core structure of these specimens in the annealed condition is of interest also. Figs. 4 and 5 are typical of the two types of structures seen in these series; that of Fig. 4, specimen A7, containing 1.70 per cent. of chromium, and 3.15 per cent. of silicon, is pearlitic with carbides and nodular graphite. Specimen A17, containing 2.45 per cent. of chromium, and 4.45 per cent. of silicon, is illustrated in Fig. 5. A larger amount of graphite is shown dispersed in the ground-mass, which appears to consist of some areas having eutectoid characteristics and a ferritic structure. The bright white globules may be carbides, but they also resemble free silicides, and they strongly resemble the free silicide constituent as recognised in other silicon-rich alloys. Structures similar to that of A17 appeared in A18, A16, A13 and A14.

TABLE I.—*Silicon Series. Chemical Composition, Hardness and Depth of Penetration.*

Sample No.	Chemical analysis. Per cent.				Brinell hardness.		Nitrogen-hardened at—					
							500 deg. C.		550 deg. C.		600 deg. C.	
	T.C.	Si.	Cr.	Al.	As-cast.	Annealed.	Hardness.	Depth. mm.	Hardness.	Depth. mm.	Hardness.	Depth. mm.
A 3	1.61	2.11	1.76	0.85	557	340	894	0.10	1,071	0.13	758	0.40
A 5	1.69	2.44	1.68	0.75	568	351	894	0.10	1,071	0.13	690	0.41
A 7	1.72	3.15	1.70	0.77	587	364	959	0.07	1,031	0.13	782	0.42
A 10	1.69	3.24	1.78	0.87	538	364	959	0.14	1,071	0.09	690	0.40
A 15	1.64	3.90	1.78	0.76	578	364	959	0.08	1,071	0.10	690	0.33
A 18	1.85	4.98	1.85	0.80	551	402	959	0.05	1,031	0.07	549	0.26
A 4	1.67	1.92	1.90	0.64	551	375	835	0.10	1,071	0.14	782	0.43
A 6	1.78	2.49	2.15	0.74	587	364	959	0.13	1,071	0.12	808	0.36
A 8	1.77	2.87	2.33	0.66	551	364	835	0.10	1,071	0.13	782	0.40
A 11	1.76	3.48	2.11	0.78	627	364	959	0.14	1,071	0.12	782	0.34
A 16	1.94	4.79	2.30	0.75	578	418	1,203	0.12	1,071	0.10	690	0.31
A 9	1.72	2.91	2.71	0.77	587	364	959	0.12	1,071	0.10	734	0.36
A 12	1.75	3.38	2.61	0.85	587	364	835	0.14	1,071	0.10	734	0.37
A 13	1.85	4.07	2.87	0.80	606	418	835	0.08	1,071	0.12	734	0.33
A 17	1.78	4.42	2.45	0.83	488	387	1,112	0.08	1,071	0.09	670	0.38
A 14	1.65	4.98	2.68	0.91	627	387	—	—	1,031	0.09	632	0.29
B 3	2.29	2.58	1.74	0.88	—	340	894	0.13	1,112	0.11	690	0.37
B 5	2.27	2.82	1.50	0.92	—	321	894	0.12	1,112	0.14	782	0.40
B 10	2.18	3.48	1.67	0.66	—	332	959	0.11	1,031	0.10	670	0.42
B 16	2.07	4.18	1.51	0.83	—	369	959	0.09	1,071	0.09	680	0.36
B 2	2.35	1.83	2.16	0.92	—	340	1,031	0.11	1,071	0.12	835	0.41
B 6	2.18	2.68	2.12	0.89	—	364	894	0.12	1,031	0.11	864	0.40
B 8	2.16	3.20	1.97	0.66	—	340	894	0.10	1,112	0.12	712	0.37
B 12	2.10	3.15	1.88	0.93	—	340	959	0.11	1,071	0.13	690	0.35
B 14	2.10	4.14	1.81	0.82	—	375	959	0.06	1,071	0.10	758	0.30
B 17	2.13	4.32	2.09	0.69	—	418	1,031	0.06	1,071	0.09	670	0.29
B 9	2.24	3.20	2.66	0.66	—	340	1,112	0.12	1,071	0.11	734	0.37
B 15	2.16	4.14	2.31	0.84	—	375	959	0.11	1,071	0.10	690	0.33
B 18	2.13	5.26	2.47	0.81	—	402	959	0.05	1,031	0.09	758	0.31

Mechanical Properties

The mechanical properties of the material in the annealed condition prior to hardening were

* A Paper read before the Iron and Steel Institute.
† Journal of the Iron and Steel Institute, 1932, No. I, p. 223; also FOUNDRY TRADE JOURNAL, May 5, 1932, p. 279.

determined on the annular-ring-form specimens by the methods described by the author in previous Papers. These results are summarised in Table II. The uniform character of these is a useful guide as to the general soundness and homogeneity of these aluminium-bearing alloys. The modulus of elasticity (EN value) appears to be uniform in all specimens in the A series up to about 4.5 per cent. of silicon. Above this silicon content the modulus of elasticity drops quite pronouncedly. The increment in the chromium contents appears to be without influence on this property. In the B series with the higher total carbon content the values of this property are at a slightly lower level, but otherwise the same remarks apply. The magnitude of the modulus of elasticity at 25.0 × 10^6 lbs. per sq. in. approximately is, of course, substantially higher than that of ordinary grey cast irons.

The ultimate breaking strength values are extremely high, and decline gradually with increasing silicon contents in the A series. The increase in carbon content in the B series is accompanied by a substantial drop in this ultimate breaking strength value, but the same decline with increase in silicon content is revealed. Within the ranges examined the chromium contents do not appear to affect substantially these strength results.

The permanent set values in the A series are extremely low, and show the same tendency as the strength values, *i.e.*, to vary with the silicon contents, increasing with increasing silicon. The increase in silicon in the B series is also accompanied by quite a marked increase in the permanent set value.

In the annealed condition there is evidence that the higher ranges of silicon content are accompanied by a sensible increase in the hardness value. This effect is apparent in both the A and B series (Table I).

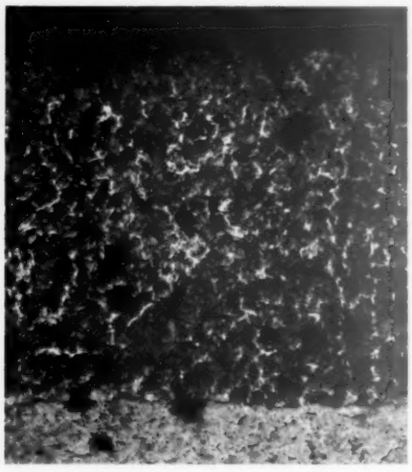


Fig. 1a.—Specimen A4 Nitrogen Hardened at 600 deg. C. The Light Area at the Bottom indicates the Case Depth.

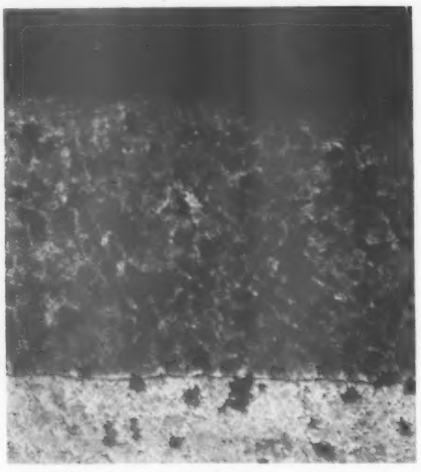


Fig. 1b.—Specimen A12 Nitrogen Hardened at 600 deg. C. The Light Area at the Bottom indicates the Case Depth.

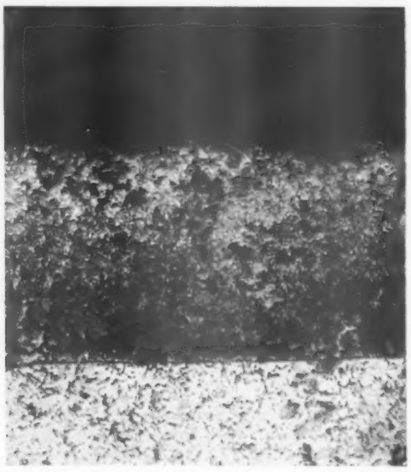


Fig. 1c.—Specimen A14 Nitrogen Hardened at 600 deg. C. The Light Area at the Bottom indicates the Case Depth.

Table II.—*Silicon Series. Mechanical Properties.*

Specimen No.	Modulus of elasticity (EN value). Lbs. per sq. in.	Tensile strength (ring test). Tons per sq. in.	Permanent set. Per cent.
	× 10^6.		
A 3	25.8	45.8	1.62
A 5	26.0	43.0	1.85
A 7	25.3	30.3	1.83
A 10	25.4	36.2	1.85
A 15	25.0	28.0	1.60
A 18	24.0	22.5	2.51
A 4	25.9	49.3	1.00
A 6	25.8	31.2	1.68
A 8	24.8	49.3	2.42
A 11	24.7	32.9	3.27
A 16	25.1	22.4	1.50
A 9	25.4	49.9	1.61
A 12	25.9	24.8	3.27
A 13	25.0	34.3	1.66
A 17	25.2	28.4	2.18
A 14	22.6	18.9	3.17
B 3	22.5	29.7	2.50
B 5	23.5	31.1	2.84
B 10	22.8	24.1	3.47
B 16	22.7	27.7	3.47
B 2	24.5	29.6	2.85
B 6	23.9	26.4	2.42
B 8	24.0	36.6	3.12
B 12	22.9	34.7	2.77
B 14	24.7	28.0	2.64
B 17	24.7	23.2	3.35
B 9	24.5	35.1	2.75
B 15	24.0	31.7	1.96
B 18	25.0	26.2	2.41

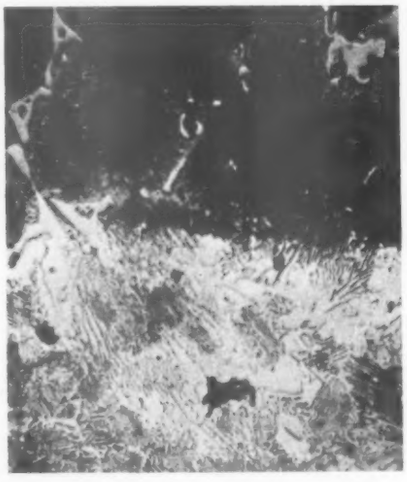


Fig. 2.—Specimen A7 Nitrogen Hardened at 600 deg. C, showing the Junction of Case and Core. Etched. × 600.

Growth

It has been mentioned already that the specimens nitrided at 600 deg. C. showed visible signs of substantial swelling at the edges of the specimens. The ring-form specimens treated possessed a rectangular cross-section, and it was found possible to measure the radial thickness of the rings after nitriding and to compare the results with the same measurement on the rings before subjection to the nitrogen-hardening treatment. In all cases there was an increment, and the increments for each specimen at each nitriding temperature are assembled in Table III. This increment in radial thickness is an index of the extent of the growth. It will be seen to increase with increasing nitriding temperature, although the increase at 550 deg. C. is not nearly so great as that at 600 deg. C.

Table III.—*Silicon Series. Increment in Radial Thickness (Growth) at Various Nitrogen-Hardening Temperatures.*

Specimen No.	Nitrogen-hardening temperature.		
	500 deg. C.	550 deg. C.	600 deg. C.
	In.	In.	In.
A 3	0.0015	0.0018	0.0052
A 5	0.0016	0.002	0.0033
A 7	0.0023	0.0023	0.0037
A 10	0.0016	0.0025	0.004
A 15	0.0014	0.0022	0.004
A 18	0.0019	0.0025	0.0042
A 4	0.0014	0.0028	0.0034
A 6	0.001	0.0029	0.0031
A 8	0.0014	0.002	0.0038
A 11	0.0018	0.0027	0.0035
A 16	0.0013	0.003	0.0043
A 9	0.001	0.0022	0.004
A 12	0.0012	0.002	0.0034
A 13	0.0017	0.0024	0.0065
A 17	0.0016	0.0028	0.0065
A 14	—	0.0023	0.0052
B 5	0.0016	0.0018	0.0041
B 10	0.0019	0.0016	0.0043
B 16	0.0017	0.0022	0.0051
B 6	0.0017	0.0026	0.0035
B 8	0.0019	0.0020	0.0035
B 12	0.0015	0.0023	0.0040
B 14	0.0014	0.0021	0.0035
B 17	0.0016	0.0024	0.0043
B 9	0.0014	0.0020	0.0035
B 15	0.0015	0.0020	0.003
B 18	0.0015	0.0020	0.004

The silicon and chromium contents do not appear to have any direct effect on these growth values, but it is somewhat remarkable that in the high-silicon ranges, where the penetration depth has diminished, the increment in radial thickness maintains a value equal to that for the lower silicon contents for each nitriding temperature.

The increment in carbon in series B does not appear to be accompanied by any increase in growth as measured in this manner.

Phosphorus

The specimens for the study of the influence of phosphorus were prepared by the addition of ferro-phosphorus to the standard aluminium-chromium alloy cast iron used for nitrogen hardening. The chemical analyses of the specimens used are set out in Table IV, and the

TABLE IV.—*Phosphorus Series. Chemical Composition.*

Specimen No.	T.C. Per cent.	C.C. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	Cr. Per cent.	Al. Per cent.
P 1	2.57	1.04	2.44	0.57	0.095	1.49	1.36
P 2	2.51	0.95	2.53	0.57	0.190	1.53	1.38
P 3	2.59	0.98	2.63	0.59	0.40	1.57	1.33
P 4	2.62	0.99	2.63	0.62	0.53	1.53	1.42
P 5	2.49	0.95	2.68	0.62	0.80	1.55	1.44
P 6	2.62	1.15	2.72	0.65	1.36	1.49	1.40

mechanical properties, hardness and depth of penetration of the nitrided surface in Table V.

The specimens used in these experiments were prepared in a manner exactly similar and from similar materials to those described in the author's previous Paper (*loc. cit.*), and they were subjected to the same kind of annealing treatment as that described for the silicon series. The mechanical properties in this condition show a very slight falling-off in the modulus of elasticity and tensile strength in the higher-phosphorus members of the series. The hardness is definitely higher in the specimen containing 1.36 per cent. of phosphorus, both in the as-cast and the annealed conditions.

The hardness and total depth of penetration values for these specimens after treatment for a period of 90 hrs. under the standard nitrogen-hardening conditions at a temperature of 500 deg. C. are given in Table V. These results indicate a marked reduction in hardness in the specimens containing phosphorus in excess of 0.19 per cent. The total depth of penetration of the hardness effect does not appear to be affected substantially.

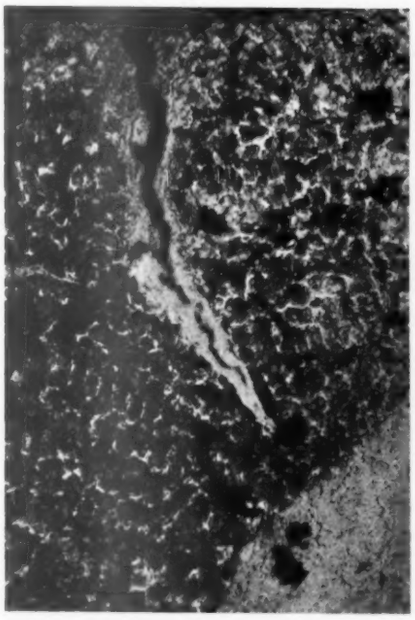


FIG. 3.—SPECIMEN A7 NITROGEN HARDENED AT 600 DEG. C. NOTE THE CRACK AT THE CORNER OF THE CASE. ETCHED. × 80.

TABLE V.—*Phosphorus Series. Mechanical Test Results.*

Specimen No.	Modulus of elasticity (EN value). Lbs. per sq. in.	Tensile strength (ring test). Tons per sq. in.	Permanent set. Per cent.	Hardness.		Nitrogen-hardened at 500 deg. C.	
				As-cast.	Annealed.	Hardness.	Depth, In.
	× 10⁶.						
P 1	22.3	23.4	3.9	341	291	835	0.010
P 2	23.2	23.2	3.1	321	291	959	0.009
P 3	22.0	25.6	4.8	341	291	614	0.010
P 4	22.8	25.8	3.4	341	305	758	0.010
P 5	21.0	21.7	3.6	341	305	650	0.012
P 6	21.7	23.0	3.3	363	320	580	0.009

TABLE VI.—*Manganese Series. Chemical Composition.*

Specimen No.	T.C. Per cent.	C.C. Per cent.	Si. Per cent.	Mn. Per cent.	P. Per cent.	Cr. Per cent.	Al. Per cent.
M 0	2.57	1.04	2.44	0.57	0.095	1.49	1.36
M 1	2.62	1.56	2.44	1.39	0.103	1.51	1.64
M 2	2.66	1.56	2.44	1.98	0.12	1.49	1.64
M 3	2.62	1.53	2.44	2.11	0.13	1.51	1.42

TABLE VII.—*Manganese Series. Mechanical Test Results.*

Specimen No.	Modulus of elasticity (EN value). Lbs. per sq. in.	Tensile strength (ring test). Tons per sq. in.	Permanent set. Per cent.	Hardness.		Nitrogen-hardened at 500 deg. C.	
				As-cast.	Annealed.	Hardness.	Depth. In.
	× 10⁶.						
M 0	22.3	23.4	3.4	341	291	835	0.010
M 1	25.0	25.9	4.3	341	320	890	0.010
M 2	24.6	24.7	2.2	341	335	808	0.010
M 3	24.5	22.8	2.9	363	335	835	0.009

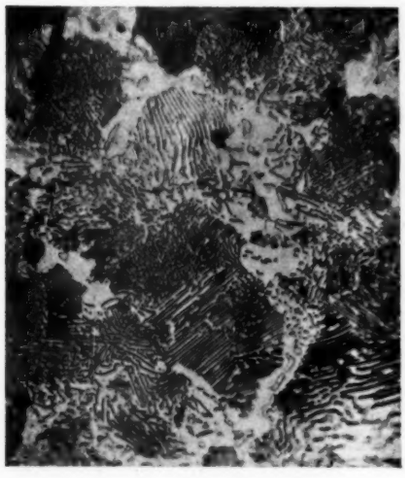


FIG. 4.—SPECIMEN A7 ANNEALED. ETCHED. × 600.

Manganese

A short series of four specimens prepared exactly like the phosphorus specimens described previously was examined. The increments in the manganese content were obtained by the addition of ferro-manganese to the molten metal in the oil-fired crucible furnace. The chemical analyses and the test results obtained are set out in Tables VI and VII.

The analyses show that a substantially higher combined carbon content is maintained in the annealed condition in the higher-manganese specimens. This is reflected in the higher hardness values of these same specimens in the annealed condition. The three high-manganese specimens have a distinctly higher modulus of elasticity, and this does not appear to be affected by the variation in the manganese content from 1.39 to 2.11 per cent. The tensile strength also is higher in the high-manganese specimens, although M3, with 2.11 per cent. of manganese, gave a low result.

The hardness of total depth of penetration values after nitrogen-hardening for a period of 90 hrs. under the standard conditions at a temperature of 500 deg. C. are included in the Table. From the character of these results it is legitimate to conclude that, within the range examined, manganese is without effect on either the hardness or the total depth of penetration after this nitrogen-hardening treatment.

FIG. 5.—SPECIMEN A17 ANNEALLED. ETCHED. × 600.

Summary and General Remarks

Within the ranges of chemical composition examined, the experimental results described show that a variation in the silicon content has no effect upon the degree of surface hardness obtained during nitrogen-hardening. The amount of silicon present does appear to have an influence upon the depth of penetration, the higher the silicon content, the lower being the depth of penetration. The experimental results demonstrate also that the effect of chromium is in the direction of ensuring greater depth of penetration, rather than affecting the degree of the surface hardness.

In the case of phosphorus, the results show that with this element in excess of 0.20 per cent. a reduction in surface hardness is obtained, but the total depth of penetration of the hardening effect is not altered. Manganese appears to be without effect upon either the hardness or the total depth of penetration.

Nitrogen-hardening at the three temperatures of 500, 550, and 600 deg. C. was examined in

(*Concluded on page* 356.)

The Institute Elects New Members

At a Council meeting of the Institute of British Foundrymen, held in Newcastle-upon-Tyne on April 17, the following were elected to the various grades of membership.

As Subscribing Firm.

Glenfield & Kennedy, Limited, engineers and ironfounders, Kilmarnock (Representative, H. Gardner).

As Members.

E. Barron, foundry manager, T. Clarke & Sons, Sheffield; H. J. Beck, foreman moulder, Ley's Malleable Castings Company, Limited, Derby; F. A. Bloor, foundry foreman, Ley's Malleable Castings Company, Limited, Derby; R. H. Buckland, production manager, Ley's Malleable Castings Company, Limited, Derby; G. R. Buckley, assistant foundry manager, Dorman, Long & Company, Limited, Middlesbrough; F. C. Chamberlain, works manager, Cochranes (Middlesbro') Foundry, Limited; A. G. Colley, general manager, Parkinson Steve Company, Limited, Birmingham; C. J. Dadswell, Ph.D., foundry manager, English Steel Corporation, Limited; R. Dickson, ironfounder, Lion Foundry Company, Limited, Kirkintilloch; S. Evans, M.Sc., general manager, Brockhouse Castings, Limited; H. V. Fell, steel foundry manager, Vickers-Armstrong, Limited.

B. Gale, technical representative, Qualcast, Limited; T. Goodwin; C. Grice, foundry manager, Hayward-Tyler & Company, Limited, Luton; H. V. Grundy, assistant superintendent of foundries, Metropolitan-Vickers, Limited; F. Gudgeon, works manager, International Combustion, Limited; W. M. Higgott, foundry superintendent, Richards (Leicester), Limited; J. O. Hitchcock, B.Sc., metallurgist, Mond Nickel Company, Limited; H. J. Hosie, director, Industrial Vehicles (Ireland), Limited; F. Houghton, director, Pickford Holland & Company, Limited; W. R. Jackson, engineer, A. J. Jackson, Limited, Kingswood; J. B. Jubb, training for foundry executive, Edgar Allen & Company, Limited, Sheffield; J. Lowe, district manager, Norton Grinding Wheel Company, Limited; F. Mileson, works manager, General Gas Appliances, Limited; H. J. Miller, M.Sc., metallurgist, Copper Development Association; A. Patrick, foundry manager, Lion Foundry Company, Kirkintilloch; R. S. Pratt, metallurgist, P. Pierce & Company, Wexford; H. U. Redshaw, production manager, Qualcast, Limited, Derby; C. J. Roberts, ironfounder, Roberts & Morris, Trowbridge; S. Simpson, foundries supervisor, Taikoo Dockyard & Engineering Company; G. A. Smith, foundry manager, Gloucester Foundry, Limited; H. Taylor, B.Sc., steel melting manager, Vickers-Armstrong, Limited, Newcastle; C. A. G. Thomson, Scottish manager, General Refractories, Limited, Glasgow; T. R. Twigger, metallurgist, British Piston Ring Company, Limited; R. T. Willcocks, managing director, Willcocks & Sons, Limited, Buckfastleigh.

As Associate Members.

T. A. Aveline, foundry fettling shop foreman; W. L. Beasley, chemist, F. H. Lloyd & Company; T. Brown, patternmaker, W. M. Lee & Sons, Dronfield; L. Buckley, foundry foreman, General Gas Appliances, Limited, Audenshaw; R. F. Coates, assistant foundry foreman, Ransomes, Sims & Jeffries, Limited; L. R. W. Davey, foundry underforeman, Ransomes, Sims & Jefferies, Limited; G. Dick, engineer, G. & J. Weir, Limited; E. R. Dunning, foundry technical assistant, Midland Electric Manufacturing Company, Limited; E. W. Fiddian, assistant foundry manager, Dudley Foundry, Brierley Hill; F. Finch, engineer, International Combustion, Limited; C. W. Gladwell, moulder, Excelsior Foundry, Sandiacre; T. Greaves, patternmaker, Glenfield & Kennedy, Limited; G. T. Hampton, metallurgist, F. H. Lloyd & Company; L. R. Jordan, chemist, Midland Motor Cylinder Company; H. W. Keeble, metallurgist, W. Mills, Limited; C. Lashly, M.C., office manager, Sir W. G. Armstrong Whitworth & Company, Limited; K. C. Lythgoe, foundry manager, Wye Foundry, Limited, Willenhall.

F. F. Mather, moulder, Foster-Gwynne Company, Lincoln; H. Morris, iron moulder, National Gas Engine Company; V. S. G. Rao, foundry foreman, Tata Iron & Steel Company, Limited, India; H. J. Read, iron moulder; A. E. Rhodes, iron moulder, J. Henry, Limited, Leeds; H. N. Rust, assistant metallurgist, C. & B. Smith, Limited, Wolverhampton; John Sime, metallurgist, Forth & Steel Company, Kirkintilloch; G. Smart, junr., coremaker, Argus Foundry, Limited, Thornliebank; E. Smith, moulder, J. Ratcliffe & Sons, Wortley; W. H. Smith, patternmaker, Craven Bros. (Manchester), Limited; H. C. Stewart, apprentice moulder, Grahamston Iron Company, Falkirk; R. Sutcliffe, B.Sc., metallurgist, Fordath Engineering Company, Limited; B. S. N. Swami, foundry chargehand, Central Workshops, Mysore Railways, India; W. Vickerstaff, castings inspector, Excelsior Foundry; S. W. Wells, assistant manager, J. Wells, Limited; A. Whiteley, chief progress clerk, Ley's Malleable Castings Company, Limited; R. M. Yates, castings inspection foreman, Austin Motor Company, Limited.

As Associates.

A. R. Currie, foundry clerk, C. P. Kinnell & Company, Limited; J. R. Parker, engineer, J. Lund, Limited, Cross Hills, Yorks; J. Sutherland, junior chemist, Babcock & Wilcox, Limited.

As Associate (Student).

H. B. Wight, apprentice ironfounder, Sir W. G. Armstrong, Whitworth & Company, Limited.

The South African Branch

The following have been elected to the various grades of membership in the newly-formed South Africa Branch:—

As Subscribing Firms.

Central Engineering Works, Johannesburg (Representative, J. Flucker); City Engineering Works, Limited (Representative, L. Bernstein); East Rand Engineering Company, Limited, Germiston (Representative, D. M. Davidson); Rowe Jewell & Company, Johannesburg; South African Railways and Harbours, Pretoria (Representative, W. A. J. Day); Union Steel Corporation of South Africa, Limited; Wright Boag & Company, Limited, Johannesburg (Representative, P. M. Boag).

As Members.

A. G. Anderson, steelworks manager, Union Steel Corporation of South Africa, Limited; H. Clarke, steelworks manager, Union Steel Corporation of South Africa, Limited; V. L. Dean, managing director, Rowe Jewell & Company; T. N. Dewar, director of companies, Union Steel Corporation of South Africa, Limited; J. A. Durie, general manager, Rowe Jewell & Company; J. A. Durie, junr., chief draughtsman, Rowe Jewell & Company; T. Hirsch, technical assistant, Union Steel Corporation of South Africa, Limited; A. E. Lintott, mechanical engineer, Central Engineering Works, Limited; D. Lion-Cachet, works manager, East Rand Engineering Company, Limited; A. G. L. Lewis, metallurgist, South Africa Iron & Steel Corporation, Limited; J. N. Mackenzie, chairman, Wright Boag & Company; R. D. Mackintosh, engineer, T. Begbie & Company, Middelburg; G. Robson, general works manager, Union Steel Corporation of South Africa, Limited; R. H. Smith, works manager, Rowe Jewell & Company; H. Teubes, B.Sc., chemical engineer, East Rand Engineering Company.

As Associate Members.

H. J. Bragg, foreman steel moulder, Union Steel Corporation of South Africa, Limited; T. Coates, foreman moulder, Rowe Jewell & Company; D. R. Godfrey, foreman moulder, Rowe Jewell & Company; D. MacGillivray, foreman moulder, East Rand Engineering Company, Limited; A. H. Mackay, foreman patternmaker, Central Engineering Works, Limited; A. Mildren, foreman patternmaker, Rowe Jewell & Company; D. Paton, foreman patternmaker, Rowe Jewell & Company; R. J. P Rosewarne, foreman patternmaker, Central Engineering Works, Limited; J. Scorgie, foreman patternmaker, East Rand Engineering Company; W. C. Simpson, chargehand patternmaker, Union Steel Corporation of South Africa, Limited; C. G. Stratford, foreman moulder, Central Engineering Works, Limited.

As Associates.

W. Dick, ironmoulder, East Rand Engineering Company; A. W. Symmonds, moulder, East Rand Engineering Company.

Some Experiments on the Influence, etc.

(*Concluded from page* 355.)

the case of the silicon series of specimens. It is of interest to note that the temperature of 550 deg. C. was accompanied by the highest and most uniform hardness results, and the depth of penetration increased with an increase in the hardening temperature. In a like manner the magnitude of the growth increased with increasing hardening temperature, and the somewhat remarkable result was obtained that this growth appears to be independent of the depth of penetration and also to be unaffected by the silicon and chromium contents. The growth at 600 deg. C. was of a visibly substantial order, and was accompanied by swelling and cracking at the corners and edges of the specimens. The case obtained at this temperature was extremely brittle and friable, and it is possible that the low surface hardness values are in a large measure to be ascribed to this brittle and friable condition.

The structural characteristics of the specimens examined have been recorded and are those obtained after submitting the specimens to a uniform annealing treatment. It is recognised that the structural characteristics of cast iron suitable for nitrogen-hardening are of importance, but further investigation of the effect of other heat-treatments upon the structure and the nitrogen-hardening properties has not yet been completed.

The author is indebted to the directors of the Sheepbridge Stokes Centrifugal Castings Company, Limited, and Bradley & Foster, Limited, for permission to publish these results.

Iron and Steel Output

The British Iron and Steel Federation report that there were 117 furnaces in blast in the United Kingdom at the end of March, compared with 115 furnaces at the end of February, five furnaces having been blown in and three furnaces having ceased operations during the month. The production of pig-iron in March amounted to 680,300 tons, compared with 603,700 tons in February, and 633,600 tons in March, 1936; the month's production includes 137,100 tons of hematite, 396,900 tons of basic, 113,500 tons of foundry, and 14,600 tons of forge pig-iron. The production of steel ingots and castings in March amounted to 1,109,500 tons, compared with 995,900 tons in February and 980,100 tons in March, 1936.

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CAST IRON
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3″ DIA.—9 FEET AND 12 FEET LONG.
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These pipes are subjected to a much improved method of heat treatment which ensures perfect physical conditions.

The quality, section and capability of long life of these pipes is of the best, and fully up to the usual high standard of all STAVELEY PRODUCTS.

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- Low Carbon Malleable
  (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

Typical Cylinder Pig Iron Specification

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

Typical Malleable Pig Iron Specification

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO., LTD.
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Foundry Selling Practice

THE PRICE AND DELIVERY BOGIES

By ERIC N. SIMONS

The heavy pressure which is being brought to bear on the foundry industry at the present moment tends to obscure certain difficulties of foundry selling officials, while at the same time enhancing others. Plenty of orders are to be had, so that the task of obtaining them is less arduous, but, on the other hand, most foundries are paying special attention, as is only right, to their old customers, and are in a position to choose from the remainder, if they feel so disposed.

There is a regrettable tendency to adopt a good-natured attitude towards one's competitors when getting business, and to argue that since one has a good share of orders, one should not be greedy, and should let Jones and Smith and Robinson have their share in turn. In other words, when the foundry is well-filled, let your competitor have a chance.

While this is expressive of an innate desire for tolerance, it is a policy definitely harmful to the efficiency of the foundry itself and of the foundry industry as a whole. Either one is in business competitively, or one is not. If one is, then competition should be maintained up to the hilt, not in the petty trickeries and sharp practices that have been known to disfigure business, but in the supplying of trustworthy castings at the lowest economical price. If Smith can get enough orders to fill his foundry because he is well organised in every direction, why should he stand aside and let the remainder go to Jones and Robinson? This is merely to bolster up their slackness, and rob himself of the benefit of his own foresight and powers of organisation. If he can get more orders than he needs, his bounden duty to himself, his men, and his shareholders, and to the industry as a whole, is to expand, until he can absorb more. If one is in complete charge of a well-run foundry, one should make it a daily and hourly aim to make the works so efficient that they drive every other foundry out of business, or compel them in self-defence, to be as efficient. This is not rapacity nor cruelty, nor is it in the long run a bad policy. It is definitely sound, fair and reasonable. The brains that organise a foundry are an asset to the community, and as such they should be utilised to the full.

Of course, no foundry would, in the long run, drive every other out of the business. What would happen is that the more intelligent managements would perceive the threat, and drastically reorganise to meet that competition. The rest would go to the wall, where they fundamentally belong.

Extensions to Overcome Slackness

For foundries to tell their representatives to "go slow" in attempting to obtain new accounts "because we have got as much as we can do with" is wrong. The proper thing is to instruct the representatives that, owing to heavy demand, the works are being extended, and orders should be obtained to fill the extension. One important point, however, should be borne in mind. To extend *without* the orders is not good policy. First, get the orders, and extend as demand grows. The position may then arise, of course, that if trade slackens, a bigger area of plant is left idle. If the foundry has kept its selling force on the alert; not allowed them to grow slack; maintained an efficient personnel; developed a fine technique for production; controlled its costs so closely that it knows to a shilling what each job costs; what work is profitable and what is not, it will be able when bad times come to take on work at prices and to give deliveries that less well-organised foundries cannot attempt. It will thus survive the bad trading periods more successfully by reason of its intense drive in good and bad times alike.

The foundry that, to-day, finds itself rushed, should not ignore new accounts, however small. They may, in the rush periods, be a nuisance, and may not, at the moment, suggest large profit. Every new account is an account taken from a competitor, however, and in times to come, when work decreases, those customers who have been obliged and won during the rush may help to provide the bread-and-butter that will keep the foundry going.

The Friendly Competitor

Only too often, Smith knows Jones, plays golf with Robinson, and sits next to Brown in the club dining room, and ceases to regard these men, his rivals, as competitors. They become "jolly good fellows," whom he does not wish to irritate or whose livelihood he feels it is a friend's job to preserve. That is merely sentimentality. By all means play fair with these men, but in business compete with them up to the hilt. It will be as good for them as for the foundry, making them win their living by the exercise of wit and intelligence. The community will gain by better goods, better prices, and better organisation, and quite probably by better wages.

The representative soliciting orders for foundries to-day is placed, if he be keen and alert, in an uncomfortable position. As a loyal servant he knows that it is his job to do the best for the foundry by opening as many new accounts as he can, increasing his turnover, taking advantage of any reluctance to accept work by Brown, Jones, and Robinson. On the other hand, as a member of the firm, he knows that work is so prolific that an order for a new customer, especially if it be not of any magnitude, will cause comments in the foundry such as "What does X want to send in those trifling orders for?" or "What time have we to bother with a few stainless castings?" or "Why should we rush these castings for Bloomington's, when they've never given us a single order before?"

Delivery Promises

He will find that among his potential customers he will be met with the query: "But what delivery can you give? It's no good quoting eight weeks; or "If I give you these orders, will you help us by giving quick delivery?" or "You can have this job if you'll take it at such and such a price." What is he to do? Take the orders or refuse them? In either event he seems to himself to be doing wrong. By taking them, he will harass the overworked foundry. By refusing them, he definitely puts it out of his power to win a new account in the future.

It should not be the representative's job to solve a difficulty of this kind. The foundry should back up the salesman in taking every worthwhile order he can get. If a job be unprofitable or the customer makes absurd demands, let him go to the other founders, but if the job is a normal foundry line, let the salesman have it, and in the meantime, instal new plant and equipment, put a premium on schemes for speeding up production and delivery, and build up a trade that will carry one over the bad times.

Obviously not all these new customers will desert the foundry that has helped them when the rush is over, and even if they do not give it all their future business, they are pretty certain to share it. There *is* gratitude among human beings, even if it is not a completely trustworthy quality.

Prices

It is amusing to discuss prices with founders, and perceive how eagerly they will increase them. One would imagine that to "get a better price" was the be-all and end-all of some founders' existences. Certainly, the prices charged for castings should be inclusive of a reasonable profit. No one wants the founder to lose money, yet fundamentally it is not the good price that makes the good profit; it is the good organisation that gets the maximum yield from the price. It is often these foundrymen who eagerly make a 5 per cent. increase in raw material costs an excuse for putting up prices 10 per cent., who grumble most actively when buyers force down prices in slump times to the uttermost farthing.

If there is an agreed basic price for castings, then the man whom it benefits most is the man with the best organised and most efficiently run foundry, because his profit margin will be bigger. If there is no agreed basis, then only efficient running and good organisation can make the foundry yield a profit on competitive prices. As a ruthless logician, the author would, if he found he was losing orders on price, consistently scrutinise every item of costs, consistently stress the importance of reducing cost—not by the facile, futile and utterly inefficient method of cutting wages and salaries—but by better methods of production, of transport, or handling, of progressing. There is not nearly enough concentrated thought put into these things. A may have a good idea, and get it put into practice, with a saving as the result. Yet these good ideas are sporadic, unsystematised. In what foundry is there a committee or body of men whose task it is to study every process and movement in production with a view to simplifying or cheapening it without loss of quality? In what foundry does such a body regularly study new plant and equipment, new handling methods, new processes and discoveries, with a view to incorporating immediately such as are proved beneficial? Odd individuals with intelligence and foresight may do these things, if they have time and energy left from their jobs; but there is little systematisation of so important a part of foundry work. Only too often, one hears "I see Smith's have put in a 'Blank' machine for . . . . I should like to see it, I've only heard about it vaguely before." Ought not the speaker to have been as familiar with the machine as Smith's?

New Accounts to be Sought

The founder should, therefore, regard the present good situation not merely as an opportunity to help old friends, though help should certainly be given, but as an opportunity to take full advantage of the difficulties of other foundries. The more accounts he can open at the present time, so long as he can take the necessary steps to give the service a customer has the right to expect, the better will his order books be in days to come, when work falls off. If he cannot give these new customers the service they need, there is something definitely wrong with his organisation, his foresight or his courage. A time like this, when orders can be had almost for the asking, is precisely the time for the overhauling of the foundry in the interests of greater output, because developments and extensions can be put in hand with a reasonable expectation that their cost will quickly be met.

Price and delivery, those twin bogies of foundry selling officials at the present time, should not be allowed to go without challenge, and if the challenge be a courageous one, they vanish into thin air. Let the foundry go all out for orders, and *væ victis*!

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Approximate Analyses.

	NEWBOLD		FOUNDRY					FORGE
	No. 3	Fdry. 4	Silky	No. 1	No. 2	No. 3	No. 4	No. 4
Carbon (graphitic)	3·20	3·00	3·50	3·70	3·50	3·25	3·10	2.80
,, (combined)	0·30	0·40	0·04	0·08	0·12	0·24	0·30	0·50
Silicon	2·0 to 3·0	2·0 to 3·0	4·0 to 5·0	2·5 to 4·0	2·5 to 4·0	2·0 to 4·0	2·0 to 3·5	2·0 to 3·0
Sulphur	0·03	0·04	0·01	0·01	0·02	0·03	0·04	0·06 to 0·08
Phosphorus	0·75	0·75	1·4 to 1·5	1·4 to 1·5	1·4 to 1·5	1·4 to 1·5	1·4 to 1·5	1·4 to 1·5
Manganese	1·3 to 1·5	1·2 to 1·4	0·8 to 1·4	0·8 to 1·4	0·8 to 1·4	0·8 to 1·4	0·8 to 1·4	0·8 to 1·2

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The Week's News in Brief

Trade Talk

JOHN TINSLEY, LIMITED, engine builders, of Darlington, propose to extend their works.

THE MEN EMPLOYED in the furnace department at Shotts Iron Works have decided that, as from this week, only a 48-hr. week will be worked.

THE DIRECTORS of British Insulated Cables, Limited, have granted a day's holiday with pay to their employees on Coronation Day.

THE BRITISH ALUMINIUM COMPANY, LIMITED, are to give Coronation medals to the children of Kinlochleven, Ballachulish and Glencoe as souvenirs.

THE PARK GATE IRON & STEEL COMPANY, LIMITED, Rotherham, have decided to carry on production on Coronation Day, and to pay holiday rates to all workmen.

JOHN READHEAD & SONS, LIMITED, South Shields, have received an order from the Strick Line, of London, for two 10,000-ton steamers. The engines will also be built by Readhead's.

THE HUGHES BOLCKOW SHIPBREAKING COMPANY, LIMITED, Blyth, have bought the steamer "City of Leeds," of 1,361 tons. The vessel will arrive at Blyth within a week or so for breaking up.

THE DARLINGTON ROLLING MILLS COMPANY, LIMITED, are making additions at their Rise Carr Works, which, when complete, are expected to provide employment for another 100 workmen.

FORTY MEMBERS of the Lothians branch of the Association of Mining Electrical Engineers recently inspected the Balhardie Works, Bathgate, of the North British Steel Foundry Company, Limited.

THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, has received an order, valued at over £1,000,000, from the London Passenger Transport Board for traction control equipment for use in tube rolling stock.

B. & F. CARTER & COMPANY, LIMITED, Rochdale, announce that they have secured the order for the equipment of the first cable factory to be erected in China. The company specialises in the manufacture of special cable-making machinery.

THE SCOTTISH TRADE UNION CONGRESS is arranging conferences in Aberdeen, Dundee, Edinburgh and Glasgow to discuss the provisions of the new Factories Bill. The purpose is to outline the proposed amendments in the existing Factory Acts and to indicate where these proposals fall short of the demands of the trade union movement.

AT AN EXTRAORDINARY MEETING of the Indian Iron & Steel Company, Limited, held last week in Calcutta, all the resolutions were passed, including the proposal for the formation of a new steel company. As already reported, the new company is to be formed to erect a steelworks alongside the Indian Company's present works at Hirapur.

THE GREEK MINISTRY OF NATIONAL ECONOMY announced on April 22 that a proposal to establish an iron and steel industry has been considered by the Cabinet. Such an industry is capable of making progress in Greece, but in view of the lack of technical organisation and capital, the Government is disposed to consider proposals from foreign undertakings.

PRELIMINARY STEPS have been taken by the Joint Trades Committee of the engineering industry to launch a new wages claim at the expiration of the present agreement in July. Employers have refused to discuss the wages and working conditions of youths and apprentices, but the unions will probably insist on the right to negotiate for all their members.

A CORONATION DAY BONUS to all their employees is announced by Blackstone & Company, Limited, of Stamford, Lincs. The bonus will in each case equal the time rate for the normal number of working hours were the works to be open on May 12. Coronation year marks the Blackstone centenary, the firm having been founded in 1837, the year of the accession to the throne of Queen Victoria.

THE PORTUGUESE "DIARIO DO GOVÊRNO" of April 1 contains a LAW, No. 27615, of the same date, effective immediately, which subjects the exportation from Portugal of waste (*sucatas*), filings or clippings of iron and its alloys, or of steel, to a licence obtainable from the Ministry of Commerce and Industry. In granting licences, preference will be given to exports effected by way of compensation for the importation of manufactures of iron and its alloys, or of steel.

AN APPLICATION by the South Wales Roadway Company for the continuation of the licences of three vehicles and for licences for three new vehicles was adjourned at the South Wales Traffic Commissioners' Court at Swansea on April 21. It was adjourned so that evidence might be called as to the need of transporting by road loads of metal between Swansea and the Birmingham works of I.C.I. (Metals), Limited. An objection has been entered on behalf of the Great Western Railway.

THE BELGIAN COMPANY of General Refractories, Limited, Usines Belges de la General Refractories, are to extend their works at Andenne. The company is considering the erection of a works for the production of coke oven silica bricks in France (probably in association with an existing French company), and the French subsidiary (S.A. Generale Refractaire) is already established in Paris. In Greece, the Greek subsidiary (S.A. General Refractories of Greece), which supplies the parent company with raw materials, has purchased land near Athens, and is building a refractories works thereon. The erection of the works is being speeded up in view of the proposed establishment of an iron and steel industry in Greece. British raw materials will be largely employed in all three cases.

Company Reports

Babcock & Wilcox, Limited.—Final dividend of 6 per cent., making 10 per cent. for 1936.

William Doxford & Sons, Limited.—Dividend on the 5 per cent. cumulative participating preference shares for the half-year to December 31, 1936.

Federated Foundries, Limited. — Combined profit and loss statement of company and its subsidiaries shows net profit, after writing off £1,344 loss on realisation of investments, of £57,732; income tax, £20,675; total net profit earned by the subsidiaries for 1936 and the aggregate net balance of unallocated profit for 1935 have been transferred to the parent company, whose accounts show a sum available for distribution, etc., of £41,681; directors propose to allocate £5,525 in reduction of preliminary expenses; dividend of 2½ per cent. on the ordinary shares; carried forward, £8,972.

Contracts Open

Kirkcaldy, May 1.—Iron tubes and fittings; cast malleable pipe fittings; brass tubes and fittings, for the Town Council. The Gas Engineer, Kirkcaldy.

Redruth, May 1.—400 yds. of 6-in. spun-iron pipes, in 12 ft. and 18 ft. lengths, class B, with spigot and socket joints, for the Camborne-Redruth Urban District Council. Mr. G. P. Paige, clerk, 3, West End, Redruth.

Wellington, N.Z., June 29.—25-ton overhead travelling crane, for the New Zealand Public Works Tender Board. The Department of Overseas Trade. (Reference T.Y. 2,460.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

James Raistrick & Sons, Limited, Antley Foundry, Accrington, Lancs.—Capital, £2,000. Engineers and founders.

Hull Foundry & Engineering Company, Limited, 14, Lincoln Street, Hull.—Capital, £1,200. Directors: W. R. Tooley and W. H. Fenton.

Princes Foundry Company, Limited, Bradleys Lane, Prince's End, Tipton, Staffs.—Capital, £1,000. Directors: C. T. Hipkins and R. B. Hutchings.

Correction.—The Paper on "Cupola Practice," published in our last week's issue was reported to have been given by Mr. W. Spiers. The author's name should have been Mr. T. A. Spiers.

Personal

THE EARL OF DUDLEY has been elected President of the Birmingham Chamber of Commerce.

MR. JOHN ARNOTT, F.I.C., has changed his home address to 10, Westwood Avenue, Giffnock, Glasgow.

MR. E. W. HIVES has been elected to the board of Rolls Royce, Limited, to fill the vacancy caused by the death of Mr. A. Wormald.

MR. CHARLES THORNTON, Bathgate, a member of Dickson & Mann, Limited, engineers, has obtained patent rights for a gravity-separation apparatus.

MR. JOHN A. DALGLISH has received a presentation from the staff of Renton & Fisher, Limited, steel founders and engineers, Bathgate, on the occasion of his marriage.

MR. F. M. GAUSSEN, assistant manager of the Commonwealth Steel Company, Limited, has arrived in England from Australia and will remain here until the middle of September.

SIR HAROLD E. YARROW, BT., C.B.E., chairman and managing director of Yarrow & Company, Limited, engineers and shipbuilders, Glasgow, has been elected chairman of the Clydesdale Bank, Limited, in succession to the late Mr. Henry Allan.

MR. JAMES WINTER, of Stocksbridge, has been appointed steel-plant supervisor to the South Durham Steel & Iron Company, Limited. He is succeeding Mr. J. N. Kilby, who was recently appointed general manager of the Redbourne Hill Works of Richard Thomas & Company, Limited. For the last twelve years Mr. Winter has been at Samuel Fox & Company's works at Stocksbridge, as manager of the Siemens department. He has been a member for many years of the Iron and Steel Institute.

Will

GARDNER, E. F., of Sheffield, a director of Easterbrook, Allcard & Company, Limited, engineers' small tools manufacturers **£1,243**

Obituary

MR. JOHN GRAHAM, who was employed as a patternmaker in Grahamston Iron Works, Falkirk, and was secretary of the Patternmakers' Society, has died, aged 72.

MR. JOHN H. BELL, a director of Cochran & Company (Annan), Limited, Newbie Engineering Works, Annan, who retired during the war, died on April 23, at the age of 66.

MR. T. E. THIRLAWAY, formerly chairman of Swan, Hunter & Wigham Richardson, Limited, Wallsend, died on April 23, aged 71. Mr. Thirlaway was also a director of Barclay Curle & Company, Limited, Wallsend Slipway & Engineering Company, Limited, and the Glasgow Iron & Steel Company, Limited.

THE DEATH OCCURRED, last Saturday, at the age of 72, of Mr. David Dalrymple. A Scotsman, he went to West Bromwich in 1905 to accept a post as foundry manager at Hall End Foundry, and he continued in that capacity until his retirement a few years ago. In 1916 he was President of the Birmingham Branch of the British Foundrymen's Association, now the Institute of British Foundrymen.

THE DEATH HAS OCCURRED of Mr. Donald MacNicoll, M.I.Mech.E., M.I.Mar.E., M.I.E. and S. of Scot., joint managing director of Cockburns, Limited, engineers and non-ferrous founders, Cardonald, Glasgow. He designed the valves for the "Queen Mary," and was the inventor of the Aspinall marine turbine governor, which is used in nearly all turbine steamers in this country and abroad. Following a Paper which he delivered on safety valves to the Institute of Marine Engineers in London in 1932, he received the Denny Gold Medal, the highest award of the Institute.

Forthcoming Event

MAY 5.

Institute of Metals:—Twenty-seventh Annual May Lecture: "The Flow of Metals," by Prof. E. N. da C. Andrade, at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1, at 8 p.m.

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Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

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SCOTTISH OFFICE: 48, West Regent Street, Glasgow. Telephone: 3009. Telegrams: "Genefax, Glasgow." (Mr. C. A. G. Thomson.)

MANCHESTER OFFICE: 9, Albert Square, Manchester, 2. Telephone: Blackfriars 6130. Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell.)

SWANSEA OFFICE: Metropole Chambers, Wind Street, Swansea. Telephone: 3680. Telegrams: "Genefax, Swansea." (Mr. D. Hood-Williams.)

CARDIFF OFFICE: 17, Windsor Place, Cardiff. Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter.)

MIDDLESBROUGH OFFICE: Halifax Buildings, Exchange Place.
Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. C. Souness.)

★

Read what an IMPORTANT STEELFOUNDER says :—

"During the 40 years I have been connected with Steel Foundry work, considerable changes have taken place. Away back, we had Steel Moulders' Composition, Old Crucible Pots, etc., and each works claimed to have its own 'secret' moulding composition. High Silica Sand has eliminated practically all these from many foundries and to-day we have your 'Yorkshire Sand' which acts almost like a chill, and leaves the skin of the casting blue-black and as clean as cast iron.

The hot steel lies quietly against the wall of sand, and often when the casting has been lifted out of the mould, the latter looks as if it could be used over again, just like a permanent mould."

Raw Material Markets

Shortage of all grades of iron and steel still exists and is causing considerable inconvenience to consumers. Makers are unwilling to negotiate new business until after the publication of the revised price list, which, it is expected, will not be long delayed. It has been decided to abolish the system of rebates which was inaugurated by the Central Pig-iron Association in December, 1930. Pig-iron despatched on and after November 30 next from makers' works to consumers in zonal areas will not be eligible for rebate. The rebate is on a graduated scale and applies to large consumers only.

Pig-Iron

MIDDLESBROUGH.—It would appear that, while the requirements of pig-iron consumers are steadily expanding, the tonnage available is declining. Makers are sending out all the available iron, but deliveries are behind schedule and do not adequately cover users' growing needs. The producers can only answer that all that can be done is being done, and there is no doubt that they have throughout done their utmost to meet consumers' requirements. Quotations, of course, are purely nominal. No. 3 Cleveland G.M.B. is quoted at 81s. per ton delivered Middlesbrough, No. 4 foundry and No. 4 forge 80s., and No. 1 foundry iron 83s. 6d. New business will not be entered into until a higher level of prices has received official approval. It is estimated that current weekly output of hematite on the East Coast is around 12,000 tons. This supply enables makers to maintain a fairly consistent service to consumers, and, in addition, despatch a small tonnage to users overseas.

LANCASHIRE.—There is little or no improvement to report as to the position of pig-iron supplies in this area. Deliveries under contracts are well behind schedule and are for considerably reduced tonnages. Most users have no stocks, and those that are fortunate enough to possess supplies from which they can draw extra tonnages are able to keep their operations more or less normal. Current quotations are on the basis of 89s. for Derbyshire and Staffordshire brands of No. 3 foundry iron, with Northamptonshire at 87s. 6d., and Derbyshire forge iron at from 84s. to 86s., according to the class of consumer. Scottish foundry iron is quoted for delivery in the Manchester district at about 106s. 6d., with West Coast hematite nominal at 106s. and East Coast at 105s. 6d., both subject to the rebate of 5s. Supplies of hematite are even more difficult to obtain than are supplies of pig-iron, and local foundries are experiencing an anxious time.

MIDLANDS.—Most consumers of pig-iron in this area are receiving deliveries on a similar scale to those despatched in 1936, but this is not always possible. When it is considered that users have much more work on hand at the present time than they had last year, it will be realised that consumers are being inconvenienced. Any material expansion in production is not possible, and it is out of the question to attempt to procure supplies from other sources. For delivery to Birmingham and Black Country stations, Northants No. 3 is quoted at 83s. 6d., and Derbyshire, Lincolnshire and North Staffordshire at 83s. 6d. per ton. The demand for special-quality iron has developed considerably since the shortage of the ordinary grades became acute, and it is not now an easy matter to purchase large tonnages. Low-phosphorus iron is quoted at about £6, and refined iron is at £7 5s., minimum, delivered the Midlands. Business in hematite will continue to be restricted until after the end of June, when the revised price list will be in operation. Producers have intimated that they will then be in the position to enter into new contracts. Meanwhile, West Coast mixed numbers are quoted at £5 9s. 6d. and East Coast No. 3 at £5 8s. 6d., delivered the Midlands.

SCOTLAND.—While the available supply of local iron remains very small, a fair tonnage has entered this area from France at £7 per ton as a delivered price; but consumers are not able substantially to meet their requirements by taking up this material, even at such a high price, as the tonnage is not of sufficient volume. No. 1 foundry iron is quoted at 90s. 6d. and No. 3 at 88s., f.o.t. furnaces. No. 3 Cleveland is at 84s. f.o.t. Falkirk and 87s. f.o.t. Glasgow. Steelworks continue to be hampered by the shortage of hematite and basic iron. Mixed numbers of hematite are quoted at 98s., with basic, British and Indian, at 82s. 6d., both less 5s. rebate.

Coke

Prices remain firm and unchanged on the foundry-coke market. Consumers have heavy requirements, and are negotiating for substantial tonnages at the recently-advanced quotations. For delivery to Birmingham and Black Country stations, best Durham coke is quoted at 46s. 6d., minimum, with Welsh coke at from 47s. 6d. to 57s. 6d. per ton.

Steel

Business in the steel market has been limited largely to the renewal of contracts and consumers' extremely urgent requirements, says the official report of the London Iron and Steel Exchange. The producing works in practically all departments of the industry have sufficient work in hand to keep them busily employed for months, and are disinclined to accept fresh business until the new price schedule, which it is expected will be announced shortly, is known. Some improvement is noticeable in the semi-finished steel department, and re-rolling works which recently were obliged to close down from lack of supplies have been able to restart operations. The works producing finished steel material are operating at capacity; but they are finding it difficult to overtake arrears in deliveries. There is no sign of any shrinkage in the requirements of the home market, and the demand from oversea appears to be increasing.

Scrap

Consumers generally continue to have expanding needs, but new business is not plentiful pending the settlement of the final details of the scheme of control. The question of supplies also has to be overcome, and it would not always be possible to obtain adequate tonnages at any price. Where business can be considered, quotations are still increasing.

Metals

Copper.—The suggestion that there may be a revival of the copper restriction scheme, which was suspended on January 14, is still heard. Undoubtedly, the pronounced reaction in the metal was the cause of the rumour, but it is generally accepted that restriction will not be brought about unless there is a further substantial decline in prices. The outlook for copper is by no means clear. The restriction scheme was temporarily removed in January, and all members agreed on conditions under which curtailment would again become effective if necessary. In the United States, consumers are believed to be well covered for supplies, and it is expected that the domestic quotation, which was recently reduced to 14½ cents per lb., delivered Connecticut Valley, will be maintained at around this level for some time to come. Officials of the United States Department of Commerce announce that the increased copper production in South Africa has virtually eliminated the United States as the major source of European supply. Although the Department continues to receive predictions that copper prices may go as low as 10 cents per lb., officials regard this as based on an incomplete allowance for the enormous potential demand.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £59 15s. to £60; Friday, £60 7s. 6d. to £60 10s.; Monday, £58 2s. 6d. to £58 5s.; Tuesday, £58 5s. to £58 7s. 6d.; Wednesday, £60 10s. to £60 15s.

Three Months.—Thursday, £57 5s. to £57 7s. 6d.; Friday, £57 13s. 9d. to £57 15s.; Monday, £55 2s. 6d. to £55 5s.; Tuesday, £55 17s. 6d. to £55 18s. 9d.; Wednesday, £58 2s. 6d. to £58 5s.

Tin.—According to the April Bulletin of the International Tin Research and Development Council, published by The Hague Statistical Office, the world production of tin for the first quarter of the current year was 43,800 tons, against 39,065 tons in the corresponding quarter of 1936. World production for the year ended March, 1937, totalled 177,400 tons, against 147,000 tons in the previous twelve months. World consumption statistics are available only up to the end of February, and the total for the year ended February, 1937, was 160,391 tons, which represents an increase of about 7½ per cent. over the figure for the previous year.

This market is expected to pursue a steady course over the next few months. Rather more activity has been seen in the metal during the past week. Consumption in the United States is on a good scale, and industrial concerns are very active. The American Bureau of Metal Statistics reports that the production of tinplates in America last year established a record at 2,096,699 tons. Some 36,694 tons of tin were absorbed in this industry.

Official quotations were as follow :—

Cash.—Thursday, £269 5s. to £269 10s.; Friday, £259 10s. to £261 10s.; Monday, £253 10s. to £254; Tuesday, £255 to £255 10s.; Wednesday, £256 to £256 10s.

Three Months.—Thursday, £264 12s. 6d. to £264 17s. 6d.; Friday, £255 10s. to £255 15s.; Monday, £250 to £250 10s.; Tuesday, £251 15s. to £252; Wednesday, £252 to £252 10s.

Spelter.—Rather busier conditions have prevailed in this market during the past week, largely as a result of increased speculation. A good tonnage has changed hands on trade account. Galvanisers in the United States are well employed and the rate of operations at the mills has increased from 72 per cent. to 73 per cent. of capacity. The highest figure recorded for the past two years is only 75 per cent. The zinc quotation in the States has been reduced from 7 cents per lb. to 6.75 cents, delivered East St. Louis. The Metallgesellschaft states that the world's smelter output of spelter in February was 113,629 metric tons, as compared with 123,587 tons in January.

Daily market prices :—

Ordinary. — Thursday, £25 15s.; Friday, £25 8s. 9d.; Monday, £22 17s. 6d.; Tuesday, £24; Wednesday, £24 10s.

Lead.—Supplies for prompt delivery continue to be difficult to procure. While consumers have not shown a great deal of activity recently, it is generally thought that something of a revival will take place in the near future.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £26 2s. 6d.; Friday, £25 8s. 9d.; Monday, £24 11s. 3d.; Tuesday, £24 13s. 9d.; Wednesday, £25 1s. 3d.

Catalogue Received

Hardness Testing. A series of three leaflets, received from the Johnson Machine Company, of Nursery Road, Mitcham, Surrey, describe and illustrate some new departures in the sphere of hardness testing. In the case of the "Dwarf" portable Brinell hardness tester, although the description is a little difficult to follow, pressure is apparently applied externally by means of a vise or screw press until a pin carried on a double-shanked spring becomes flush with the ring which surrounds it. For a precision model this pin is replaced by a pressure gauge. A five-millimetre ball and a pressure of 750 kg. is used which gives results comparable with those obtained by a ten-millimetre ball and 3,000 kg. pressure. This instrument weighs only 4½ lbs. A second leaflet describes the Duroskop, which weighs only 14 ozs. In this case the instrument is simply held against the piece to be tested and a pendulum hammer is released by means of a pin mounted on the rim of the instrument. After striking the piece to be tested the pendulum rebounds, carrying with it a pointer which registers on a scale the amplitude of the rebound. Conversion tables are provided for the ready calculation of the equivalent Rockwell, Shore or Brinell figures. There are a number of "gadgets" included for dealing with chilled steel, lead, aluminium, wood, paper, wire, nails and rivets. The third leaflet describes the Triplex combination hardness testing set, which contains models of the two instruments already indicated. It does appear to us that by regularly using the two instruments under workshop conditions much really useful information would be obtained ... to materials of construction, and variations in properties.

B.A./40D ALUMINIUM ALLOY FOR LARGE CASTINGS

Ever since the value of a "modified" silicon alloy was discovered, we have supplied a rapidly increasing tonnage of our B.A. 40 D silicon alloy. Those who always use it are aware of its ease of casting, its fluidity, its high strength coupled with a quite unexampled degree of ductility. Those who have not yet tried it may find in this alloy the exact metal they have been seeking to solve their foundry difficulties.

We will gladly give further information to interested enquirers.

The illustrations show:

1. *Pouring the casting.*
2. *The rough casting being knocked out of the mould.*
3. *The finished casting.*

(These photographs are shown by courtesy of Messrs. William Mills, Ltd., Birmingham.)

THE British Aluminium CO. LTD

Head Office: ADELAIDE HOUSE, LONDON, E.C.4. Telephone: Mansion House 5561 & 8074 (6 lines). Telegrams: "Cryolite, Bilgate, London."

F.T.J. 29.4.37.

RAW MATERIALS—PRICE LIST

(Wednesday, April 28, 1937)

COPPER

	£ s. d.
Standard cash	60 10 0
Three months	58 2 6
Electrolytic	62 10 0
Tough	63 10 0
Best selected	64 0 0
Sheets	95 5 0
India	74 15 0
Wire bars	65 5 0
Ingot bars	65 5 0
H.C. wire rods	68 15 0
Off. av. cash, Mar.	72 8 11½
Do., 3 mths., Mar.	71 1 5½
Do., Sttlmnt., Mar.	72 7 11½
Do., Electro, Mar.	77 18 6½
Do., B.S., Mar.	77 5 3½
Do., wire bars, Mar.	77 18 6½
Solid drawn tubes	14½d.
Brazed tubes	14½d.
Wire	10¼d.

BRASS

Solid drawn tubes	12½d.
Brazed tubes	14½d.
Rods, drawn	11d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	10d.
Yellow metal rods	7½d.

TIN

	£ s. d.
Standard cash	256 0 0
Three months	252 0 0
English	256 0 0
Bars	258 0 0
Straits	257 5 0
Australian	—
Eastern	252 15 0
Banca (nom.)	257 10 0
Off. av. cash, Mar.	283 5 7½
Do., 3 mths., Mar.	278 19 6½
Do., Sttlmt., Mar.	283 4 0½

SPELTER

	£ s. d.
Ordinary	24 10 0
Remelted	22 0 0
Hard	21 0 0
Electro 99.9	27 0 0
English	25 5 0
India	21 0 0
Zinc dust	26 0 0
Zinc ashes	9 15 0
Off. aver., Mar.	33 5 11 1/14
Aver. spot, Mar.	33 3 9

LEAD

	£ s. d.
Soft foreign, ppt.	25 1 3
Empire (nom.)	25 8 9
English	27 0 0
Off. aver., Mar.	33 0 0⅝
Aver. spot, Mar.	33 0 6⅞

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£ s. d. to £ s. d.
Zinc sheets, English	37 10 0 to 38 0 0
Do., V.M. ex-whse.	37 10 0 to 38 0 0
Rods	33 0 0

ANTIMONY

	£ s. d. to £ s. d.
English	88 0 0 to 89 0 0
Chinese, ex-whse.	74 0 0
Crude, c.i.f.	41 0 0

QUICKSILVER

Quicksilver	13 17 0

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	12 0 0 (nom.)
45/50%	10 15 0 to 12 0 0
75%	15 15 0 to 17 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va
Ferro-molybdenum—	
70/75% carbon-free	4/9 lb. Mo.
Ferro-titanium—	
20/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22
Ferro-tungsten—	
80/85%	5/- lb. (nom.)
Tungsten metal powder—	
98/99%	5/3 lb. (nom.)
Ferro-chrome—	
2/4% car.	31 17 6
4/6% car.	22 10 0
6/8% car.	21 10 0
8/10% car.	21 10 0
Ferro-chrome—	
Max. 2% car.	32 10 0
Max. 1% car.	35 15 0
Max. 0.5% car.	36 10 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£180 to £185
"F" nickel shot	£165 0 0
Ferro-cobalt, 98/99%	7/3 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese—	
76/80% loose	£16 15 0 to 17 5 0
76/80% packed	£17 15 0 to 18 5 0
76/80% export	£20 0 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 7d.
Finished bars, 18% tungsten	3s. 6d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/16 in.	1/- lb.
Flats, ¼ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d. to £ s. d.
South Wales—	
Heavy steel	3 8 0 to 3 10 0
Mixed iron and steel	3 5 0 to 3 7 6
Heavy cast iron	3 8 0 to 3 10 0
Good machinery	3 15 0 to 4 0 0
Cleveland—	
Heavy steel	3 7 0
Steel turnings	2 12 6
Heavy cast iron	4 2 6
Heavy machinery	4 7 6
Midlands—	
Short heavy steel	3 15 0
Light cast-iron scrap	3 7 6 to 3 10 0
Heavy wrought iron	3 17 6 to 4 2 6
Steel turnings	2 2 6 to 2 5 0
Scotland—	
Heavy steel	3 4 6 to 3 7 0
Ordinary cast iron	4 5 0
Cast-iron borings	2 0 0 to 2 2 6
Wrot-iron piling	4 2 6
Heavy machinery	4 10 0
London—Merchants' buying prices, delivered yard.	
Copper (clean)	47 0 0
Brass	29 0 0
Lead (less usual draft)	19 10 0
Tea lead	15 0 0
Zinc	14 0 0
New aluminium cuttings	74 0 0
Braziery copper	42 0 0
Gunmetal	46 0 0
Hollow pewter	170 0 0
Shaped black pewter	120 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	83/6
,, No. 3	81/-
,, No. 4	80/-
Forge No. 4	80/-
Hematite No. 1	98/-*
Hematite M/Nos.	97/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	98/-*
,, d/d Birm.	109/6*
Malleable iron d/d Birm.	135/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	83/-
,, No. 3 fdry.	86/-
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/-
,, fdry. No. 3	86/-
,, fdry. No. 1	89/-
Scotland—	
Foundry, No. 1, f.o.t.	90/6
,, No. 3, f.o.t.	88/-
Cleveland No. 3, Glasgow	87/-
,, ,, Falkirk	84/-
Scottish hem. M/Nos. d/d	98/-*
Sheffield (d/d district)—	
Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	103/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	89/-
Staffs fdry. No. 3	89/-
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/-
Glengarnock, No. 3	106/6
Clyde, No. 3	106/6
Monkland, No. 3	106/6
Summerlee, No. 3	106/6
Eglinton, No. 3	106/6
Gartsherrie, No. 3	106/6
Shotts, No. 3	106/6

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d. to £ s. d.
Bars (cr.)	11 17 6
Nut and bolt iron	10 5 0 to 10 15 0
Hoops	12 15 0
Marked bars (Staffs) f.o.t.	14 7 6
Gas strip	12 15 0
Bolts and nuts, ¾ in. × 4 in.	17 10 0 and up.
Steel—	
Plates, ship, etc.	9 10 6 to 9 13 0
Boiler plts	10 0 6 to 10 3 0
Chequer plts.	11 3 0
Angles	9 3 0
Tees	10 3 0
Joists	9 3 0
Rounds and squares, 3 in. to 5½ in.	10 3 0
Rounds under 3 in. to ⅜ in. (Untested)	9 10 0
Flats—8 in. wide and over	9 8 0
,, under 8 in. and over 5 in.	9 13 0
Rails, heavy	8 5 0 to 8 10 0
Fishplates	12 10 0
Hoops (Staffs)	10 5 0
Black sheets, 24g. (4-t. lots)	14 0 0
Galv. cor. shts. (,,)	17 0 0
Galv. flat shts. (,,)	17 10 0
Galv. fencing wire, 8g. plain	16 0 0
Billets, soft	6 5 0
Sheet bars	6 2 6 and up.
Tin bars	6 2 6 and up.

PHOSPHOR BRONZE

	Per lb. basis
Strip	13½d.
Sheet to 10 w.g.	14½d.
Wire	15½d.
Rods	15½d.
Tubes	20½d.
Castings	16d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	95.00
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2·40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.15
Skelp, grooved steel	2.10
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb box	$5.35

COKE (at ovens)

Welsh foundry	32/6 to 33/-
,, furnace	27/- to 28/-
Durham foundry	32/6
,, furnace	31/6
Scotland foundry	—
,, furnace	28/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes 20×14 per box	24/- to 25/-
,, 28×20 ,,	48/- to 50/-
,, 20×10 ,,	34/6 to 35/6
,, 18¾×14 ,,	24/9 to 25/9
C.W. 20×14 ,,	21/9 to 22/9
,, 28×20 ,,	43/6 to 45/6
,, 20×10 ,,	30/- to 32/6
,, 18¾×14 ,,	22/9 to 24/9

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£12 0 0 to £13 0 0
Bars-hammered, basis	£19 0 0 to £20 0 0
Bars and nail-rods, rolled, basis	£19 0 0 to £20 0 0
Blooms	£14 0 0 to £14 10 0
Keg steel	£26 0 0 to £29 0 0
Faggot steel	£19 0 0 to £25 0 0
Bars and rods dead soft, st'.	£16 0 0 to £18 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Apr.	22 ..	59 15 0	dec. 15/-
,,	23 ..	60 7 6	inc. 12/6
,,	26 ..	58 2 6	dec. 45/-
,,	27 ..	58 5 0	inc. 2/6
,,	28 ..	60 10 0 ,,	45/-

Electrolytic Copper

		£ s. d.	
Apr.	22 ..	64 0 0	inc. 20/-
,,	23 ..	65 0 0 ,,	20/-
,,	26 ..	62 10 0	dec. 50/-
,,	27 ..	61 0 0 ,,	30/-
,,	28 ..	62 10 0	inc. 30/-

Standard Tin (cash)

		£ s. d.		
Apr.	22 ..	269 5 0	inc.	165/-
,,	23 ..	259 10 0	dec.	195/-
,,	26 ..	253 10 0 ,,		120/-
,,	27 ..	255 0 0	inc.	30/-
,,	28 ..	256 0 0 ,,		20/-

Tin (English ingots)

		£ s. d.		
Apr.	22 ..	269 10 0	inc.	160/-
,,	23 ..	260 10 0	dec.	180/-
,,	26 ..	253 10 0 ,,		140/-
,,	27 ..	255 0 0	inc.	30/-
,,	28 ..	256 0 0 ,,		20/-

Spelter (ordinary)

		£ s. d.		
Apr.	22 ..	25 15 0	inc.	41/3
,,	23 ..	25 8 9	dec.	6/3
,,	26 ..	22 17 6 ,,		51/3
,,	27 ..	24 0 0	inc.	22/6
,,	28 ..	24 10 0 ,,		10/-

Spelter (Electro, 99.9 per cent.)

		£ s. d.		
Apr.	22 ..	28 5 0	inc.	41/3
,,	23 ..	28 0 0	dec.	5/-
,,	26 ..	25 10 0 ,,		50/-
,,	27 ..	26 10 0	inc.	20/-
,,	28 ..	27 0 0 ,,		10/-

Lead (soft foreign, prompt)

		£ s. d.		
Apr.	22 ..	26 2 6	inc.	31/3
,,	23 ..	25 8 9	dec.	13/9
,,	26 ..	24 11 3 ,,		17/6
,,	27 ..	24 13 9	inc.	2/6
,,	28 ..	25 1 3 ,,		7/6

Lead (English)

		£ s. d.		
Apr.	22 ..	28 0 0	inc.	30/-
,,	23 ..	27 10 0	dec.	10/-
,,	26 ..	26 10 0 ,,		20/-
,,	27 ..	26 10 0	No	change
,,	28 ..	27 0 0	inc.	10/-

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
1901	£ s. d. 2 13 6	£ s. d. 2 17 0	£ s. d. 2 15 0	£ s. d. 2 15 0	£ s. d. 2 14 0	£ s. d. 2 13 9	£ s. d. 2 13 6	£ s. d. 2 13 6	£ s. d. 2 14 6	£ s. d. 2 13 0	£ s. d. 2 12 6	£ s. d. 2 16 6	£ s. d. 2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 17 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 18 0	2 18 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 6	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 5 6	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 14 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 8½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 0	3 10 1½	3 9 6	3 14 4½
1931	3 9 6	3 9 6	3 9 6	3 9 6	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 10
1932	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1933	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1934	3 7 0	3 9 6	3 13 2½	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 12 11½
1935	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 18 0	3 18 0	3 14 8
1936	3 18 0	3 18 0	3 18 0	3 18 0	3 18 0	3 18 0	4 3 0	4 3 0	4 3 0	4 3 0	4 3 0	4 9 0	4 1 0
1937	3 6 0	3 6 0	3 6 0	—	—	—	—	—	—	—	—	—	—

* No prices available during strike period.

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EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

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NOTICE

CENTRAL PIG IRON PRODUCERS' ASSOCIATION.

NOTICE is hereby given by the Members of the Central Pig Iron Producers' Association that in accordance with the provisions of paragraph (viii) of the Rebate Scheme brought into operation by the Members of the above-named Association on December 1, 1930, the said Scheme will be terminated on November 30, 1937, and all pig-iron despatched and invoiced from Makers' Works to Consumers' Works in Zonal Areas after that date will not be eligible for Rebate.

DAVIES SANDERS & CO.,
Secretaries to the above-named Association.

1, Gluman Gate,
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PUBLICATION

RYLAND'S DIRECTORY of the Coal, Iron, Steel, Tinplate, Metal, Engineering, Hardware and Allied Trades. 1936 edition completely out of print. Next edition 1938. Price 42s. cloth bound. Order your copy now.—INDUSTRIAL NEWSPAPERS, LIMITED, 49, Wellington Street, Strand, London, W.C.2.

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METAL Cutting Bandsaw, 30 in., required. Must be in good condition. Send full details, price, and particulars where same may be viewed, to: ANTI-ATTRITION METAL CO., LTD., Glengall Works, Glengall Road, London, S.E.15.

REQUIRED.—Second-hand Testing Machine for non-ferrous materials, capacity 10 tons. —Box 358, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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ELECTRIC CUPOLA BLOWERS (large stock), including two 50-h.p. 3/50/400 volts, 2,900 r.p.m.; Keith Blackman; 12-in. outlet.
30-h.p. ditto; 12-in. outlet.
5-h.p. ditto; 6-in. outlet.
20-h.p. 460 volts d.c., 2,400/1,900 r.p.m.; 10-in. outlet.
EXHAUST FANS (large stock), electrical and belt driven.
ELECTRIC RUNWAY LIFTING BLOCKS:
One 4½-ton 460 volts d.c., Vaughan.
Two 2-ton ditto, Morris.
One ½-ton 220 volts d.c., Morris (as new).
One ½-ton 3/50/440 volts, Aabacas.
Two Reavell Rotary Compressors, 12 lbs. sq. in. pressure; 750 cub. ft. direct-coupled on bedplate to 60 h.p. S.R., 3/50/400 volts motor.
½-cwt. Pilkington Self-contained Pneumatic Hammer.
Geared Foundry Ladles, 9, 4, 3½, 2½ and 1 ton, etc.
AIR COMPRESSORS: 30 in stock in sizes 500 to 20 cub. ft.
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'Phone: Broadwell 1359.

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LANCS. BOILER; 30′ x 7′ 6″; 150 lbs. w.p.
75-h.p. "HOLT" TRACTOR.
6-ton "Clayton" TIPPING STEAM WAGON; 200 lbs. w.p.
75′ STEEL SOCKETED PIPING; 24″ dia. in 25′ lengths.

Write for "Albion" Catalogue.

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Sturtevant B.D. Fan, 7 in. delivery.

HARRY H. GARDAM & CO., LTD., STAINES.

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GENUINE Southport Wind Blown Sand, which makes best oil-sand cores. Prompt deliveries by road into works.

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SOUTHPORT.

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4′ 0″ × 2′ 6″ Geared Rumbler; heavy pattern in good condition. Price, £28.

Large Sandblast Barrel Plant; CHEAP

5′ 0″ Rotary Table Sandblast Plant. Price £150.

Several nearly new jolt squeeze moulding machines with pattern draw.

Large stock of good foundry ladles and shanks.

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SMARTS DINAS SILICA BRICK Co., Ltd., KIDWELLY.

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